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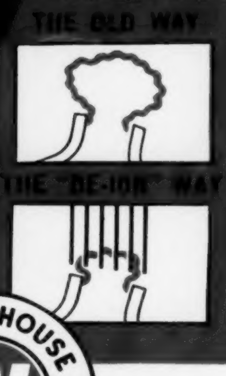

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# Who Should Represent The Steel Worker?

## Employee Representatives or Outside Interests?

*The Association of Iron and Steel Engineers has always had a keen interest in the employee. It was through the Association that the National Safety Council was organized in 1912, which organization is credited with promoting many benefits not only for the workers in the steel industry but throughout all of industrial America.*

OUT OF ALL the smoke screens surrounding the news about the current labor situation, one question clearly arises:

Just who can best represent the steel worker in his relations with his employers?

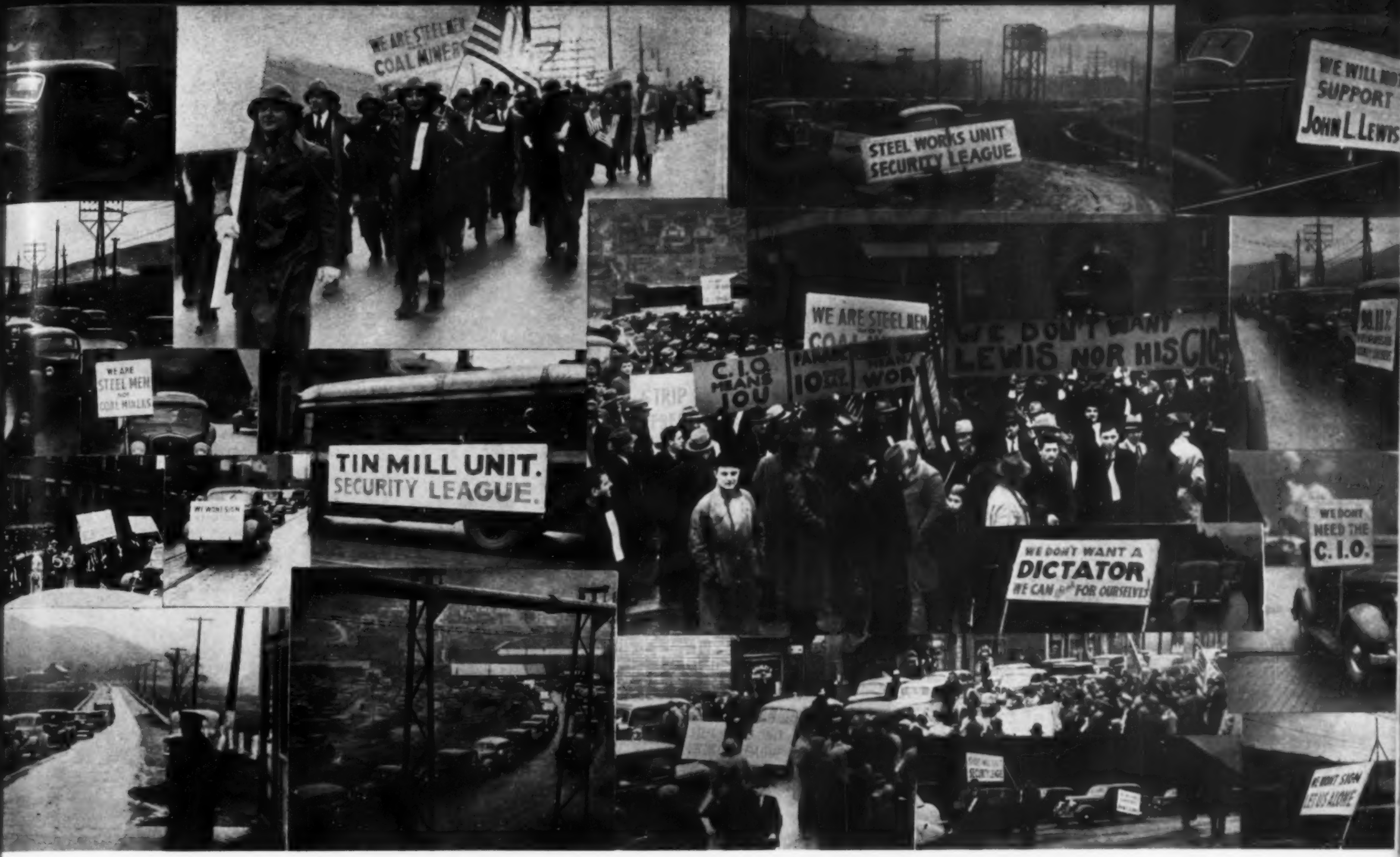
That industrial workers are going to have representation is a foregone conclusion, manifested by both the policies of the present administration and by the natural trend of conditions toward more democracy in business. At the present time, workers in the steel industry have organizations actually functioning to represent them. They are getting this representation, and the benefits that accrue, without any cost to them.

Another group wishes to replace this established system of representation with a nation wide organization, not primarily interested in the problems of the steel worker but interested in labor relations of many industries, most of which are entirely unrelated to steel.

Many of the employee representation plans are comparatively new. Naturally many initial difficulties in their operations have been encountered, but such obstacles are common to all new and unusual phases of business. The plans are not necessarily working as smoothly as they will eventually when these initial difficulties can be adjusted through the existing cooperation of employees and management. It should not be overlooked by the employees that such flexibility is one of the major desirable factors in any plan.

It seems quite obvious that the man in the steel mill can have a better spokesman by choosing his fellow workers as representatives than by having professional labor organizers whose interest probably lies more in the building up of a powerful organization for their own advantage than in actually bettering the conditions of the men in the steel mill.

So long as men in the steel industry have as their representatives men recruited from their own ranks, the problems of wages and working conditions will be settled solely on the basis of the actual situation in the steel industry. They will not be tied up with the entirely unrelated problems of coal, glass, the garment trade, and a multitude of other businesses having little or nothing in common with the problems of steel.


WE ARE STEEL MEN NOT COAL MINERS
STEEL WORKS UNIT SECURITY LEAGUE.
WE WILL NOT SUPPORT JOHN L. LEWIS
WE ARE STEEL MEN
TIN MILL UNIT. SECURITY LEAGUE.
WE DON'T WANT LEWIS NOR HIS CIO
C.I.O. MEANS IOU
STRIP
WE DON'T WANT A DICTATOR
FOR OURSELVES
WE DON'T NEED THE C.I.O.

**More articulate than words is the above illustration of the demonstration given by the employees of the Weirton Steel Company in which they pledged their allegiance to the employee representative plan. 8,000 employees participated in this parade, which in no uncertain terms warned outsiders that they don't want any intrusion in their current manager-employee relationships.**

One wonders just how the label "Company Unions" came to be so generally applied in a derogatory sense to employee plans as they exist in the steel industry. Anyone who has had dealings with the employee representation plan, as have most of the membership of the Association of Iron and Steel Engineers, knows that the employee representatives are representing the employees and not the company, that they are not controlled or dominated, and that they are engaged in intelligent, critical cooperation with management. In the long run, this should work for the good of both the men in the mills and the companies.

The 2500 operating executives and engineers of the iron and steel industry who are members of the Association of Iron and Steel Engineers should give full cooperation and assistance to whatever employee representation plans are finally perfected by the men and management of America's basic industry.

John Kelly, Jr.

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# Material Handling Facilities

## FOR HOT AND COLD STRIP MILLS

BY F. M. GILLIES,
Assistant General Superintendent
Inland Steel Company
INDIANA HARBOR, INDIANA

**Presented before the Annual Convention of the A. I. & S. E., Detroit, Michigan, Sept. 22-25, 1936**

▲ SINCE the capital investment for handling the product in hot and cold strip mills, represents approximately seven per cent of the total expenditure for construction of one wide hot strip mill, with a fifty thousand tons per month capacity, and cold reducing facilities capable of half that amount,—and since the normal cost of handling the product through the various processes amounts to approximately 25¢ per ton in the hot mill, and 95¢ per ton in the cold mill, we can readily see that the subject is one that demands thorough consideration, in order to insure not only proper selection, but proper coordination of equipment to *do* the work.

The economics of handling the material is not the only important phase. Although from any angle we may treat the subject, indirectly or directly, economics are affected. But the quality of the product itself is also tied in with proper facilities, as is also the operation of the direct processing equipment. Processing machines, capacity of which depends on the ability to operate without delay, either from having to wait for material to be brought to the machines, or to be taken away from them, are wholly dependent on the class of material handling facilities servicing them.

Fundamentally, we must always remember that the method of handling, or the number of handlings necessary, do not enhance the sales value one cent, but definitely has direct influence on the manufacturing cost. I have heard it said that it cost 10¢ every time a lift is picked up and set down, and if true, then all the efficiencies that can be installed, and properly utilized, result in definite savings in manufacturing cost, and thereby a greater margin between manufacturing cost and sales price.

Since both hot and cold strip mills are heavy production units, and since, unlike other finishing mills in the industry, the finished product must go through a number of processes, and since, fortunately, the coil, lift, or package accommodates itself well to other than overhead crane handling, much progress has been made in adoption of the various kinds of equipment for rapid easy handling.

The handling of sheets by manual labor is expensive, and any *practical* piece of equipment that can be employed in its place is worth the cost of development. From the hot coilers or hot flying shears in the hot strip mill to the truck, gondola or box car on the shipping track, close study should be made to eliminate the human hand, except in the operation of a controller of machines.

The original layout of hot, and particularly cold strip mills, should be the result of deep consideration of handling facilities. To group the processing units so that there is a minimum of transfer distance, and yet sufficient space for flexibility of supply and taking away from the unit, considering the type of machine to be used for transferring, is essential to rapid economical production. To eliminate conflicting movements of transfer equipment is a fundamental to be observed. Every pound of product which reverses its direction through its processing, must mean some delay, and —delay means greater cost.

Most of you who are interested in the subject being discussed here are familiar to a degree with the general processing—and its order in hot and cold strip mills, and rather than deal with the facilities for handling from process to process, it would be better, I believe, to name the various kinds of equipment that are used, and then describe where, and how they are best employed. This must naturally only be the opinion from the observation, and experience, of the writer; progress is being made in this type of equipment almost daily, and so the adaptation herein described will, naturally, have its limitations, all of the writer's experience comes from an operation where full realization of the economics involved exists, and where engineers are still studying the subject, in hope of further economies.

I wish to emphasize one point to those engineers interested in this class of equipment before discussing the types of equipment, and their application.

The problem of handling a material which weighs approximately 500 lbs. to the cu. ft., and handling it rapidly, and carefully, in large volumes, is unlike any other industrial handling problem. Those of you long experienced in the steel industry, know that there never was a piece of equipment built, and used, that wasn't ultimately overloaded. Capacities always exceed the original designed for limits, and in handling equipment in strip mills we have no exceptions. Perhaps the only type of equipment in these mills immune from this consideration, are the overhead cranes, and since in most cases these are designed for handling backing up rolls or housings, they are reasonably safe from overloading.

The advantages of heavier coils, or handling of larger lifts already in some mills, has made some equipment obsolete, and *may* I warn the manufacturers of handling equipment, when designing for handling certain loads in the steel industry, that they double that capacity, and their success as a manufacturer supplying this field will be much better insured.

The handling of materials in hot and cold strip mills, is accomplished by the use of the following equipment:

1. Motor driven conveyors.
2. Gravity conveyors.
3. Overhead cranes.
4. Belt conveyors.
5. Upenders.
6. Tilters.
7. Jib cranes.
8. Tractors.
9. Pack lifters.
10. Trucks (Self-loading).
11. Electric magnets.

View showing coil which has been ejected onto tractor ram.

Placing coil, by means of chain hoist on gib crane, in upender.

There are a number of types of tractors and these in turn can be broken down into the following:

1. Ram Type (High and low lift).
2. Straddle Type.
3. Fork Type (High and low lift) (Swivel type)
4. Sheet loading tractors (articulated type).
5. Towing tractors.
6. Upending tractors.
7. Tiering platform trucks.

These types can all be powered by three means; straight gas, gas electric, or straight electric. Their comparative merits will be discussed in general when the application of this type of equipment is described.

### I. Motor Driven and Gravity Roller Conveyors

Strip Mills have found this type of equipment extremely serviceable in almost all locations, where the line of travel does not conflict with the movements of tractor trucks. Many applications on the outgoing ends of single sheet processing units, where the individual sheets are piled into heavy lifts, enable the rapid movement of heavy lifts out of the way of the space used for piling, on the exit end of the process, to a point further along the conveyor, where at the convenience of crane, or tractor, the lift can be transported to where it must go next. This type of equipment is particularly well adapted to flying shear units.

Conveying coiled strip in a vertical position is handled most generally with this type of conveyor. Most modern pickling lines are supplied from the coil storage space by these conveyors, where a long feeding conveyor line, permits the overhead crane to stock up a line of this sort, preparatory to feeding the continuous pickle units, and then the crane can be released for other duties required of them. A conveyor line of this kind with a slight angle of inclination, uses gravity to perform the progressive movement controlled by braking. In this way, stout rollers with anti-friction bearings, transfers material at the convenience of the processing operation, with a minimum of upkeep, and operating expense.

Of course it is not always possible to employ gravity as the motive power, and in locations where the eleva-

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tion does not permit this type of conveyor, they are motor driven. They are also employed where it is necessary to keep a definite spacing between coils, or lifts, or to transport upgrade.

If the length of this type of conveyor system is more than one unit of conveyor, then they should be electrically interlocked, to insure the stopping of the feeding, in case the operation of the unit to be fed is interrupted.

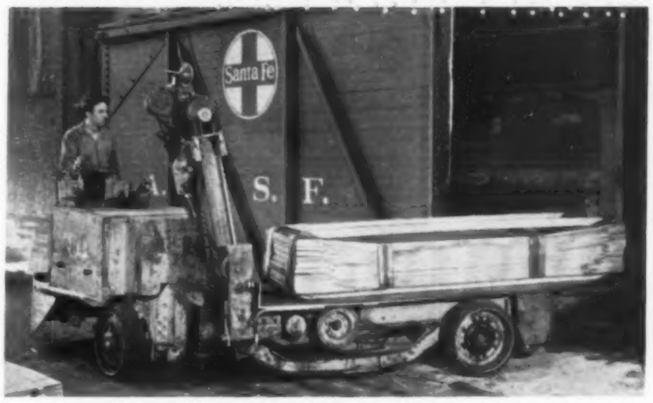
Conveyors of this type have considerable flexibility in application, because of their great variety of design, coils can readily be transported either in a vertical, or horizontal position. Rollers at bias to the angle of travel, can transfer their load laterally along with the forward travel, and the recent installation of vertical rollers, as side guides, to control the travel of extremely wide coils, guarantees conveying against mishaps.

This type of equipment has a reputation of extremely low maintenance cost, and combines with that the good feature, insurance of no damage to the product.

In cases where conveyors of this type serve processing machines, where the coil must be fed in a position at right angles to its position, on the conveyor, the use of the upender is brought into service. This machine is of simple construction, equipped with similar conveying rollers as is used in the conveying line, and whose main body swings through a 90° arc. The application of the upender comes between the coil storage, where the coils are stored in a vertical position, and the continuous pickling lines, where the coil is fed from the coil box in a horizontal position. The horizontal position is usually maintained throughout the rest of the cold strip processing, unless the material is to be annealed in coil form, and shipped in coils. The usual coil annealing practice is to load the box with the coils in the vertical position, and here again the upender comes into service, and again when it must be returned to the horizontal position for skin rolling.

The newest development for this movement is with an upending tractor truck. Trucks combining this feature have been in service in the paper industry for some time, and now I understand one of the equipment manufacturers has an order for and is constructing a truck of this kind to handle coiled strip. The obvious advantages of material handling equipment of this kind, in lieu of a stationary machine, should make the upending tractor particularly desirable.

Before going further, the use of the old stand by, the over-head crane, should come into consideration. Overhead cranes are by far the most important handlers of material in the hot strip mill, mainly, because of the weight, and size, of the lifts to be handled. Wide strip mills for convenience of high speed operation, deliver long lengths (often two multiples) as heavy as can be conveniently handled at the end of the mill runouts. From this point to normalizing furnaces, pickling units, or reshearing units, the use of conveyor equipment other than overhead cranes, is not so well adapted. Tractor trucks are used in instances, but the fork type sufficiently balanced to handle extremely heavy lifts are not practical, because of their size, which restricts maneuverability in the small space usually existant in hot strip finishing ends. From the processing mentioned, to the shipping floor, the conveyor and tractor equipment serve admirably, but again the overhead crane comes in as the best, and only serviceable method of loading the material in gondola cars or trucks. The overhead crane is still the main item for material handing in the hot strip mill.



Articulated type sheet loading tractor entering box car with 11,000 lb. load.

The cold mill, however, presents a different picture, and here, I believe the overhead crane is the most uneconomic, and inefficient unit of material handling equipment in this department, due to the immense number of units to be handled, the weight of which, is as a rule well under the capacity of the crane, which must have capacity to handle the weight of rolls, or heavy processing equipment in maintenance work. An average 15 ton crane of eighty foot span, worth $34,000 which requires the services of an operator and accompanying hooker, and the movements of which when travelling any distance, along a runway, conflicts with the operations of other necessary cranes, results in a slow expensive operation. Cranes are necessary, but installation should be held to the point of necessity, for beyond this, they only contribute to increased material handling costs. Along with the overhead crane, we must consider the pack lifter, which is as we know, a refined version of sheet lifting hooks, used for years in Sheet Mills. Many versions of pack lifter developments are familiar to us all, and have contributed to safer and easier handling of packs. The application of a midsection supporting hook, on both ends, to hold up the sag of extra wide sheets, controlled by a chain hoist on a central shaft, permits safe, rapid handling of this newer product of the wider mills, which unless supported, presents a problem, when carried in lighter lifts.

Other material handling means that deserve mentioning in this discussion, are tilters. Processing machines that handle one coil at a time, must of necessity, —to insure continuous operation, have several coils waiting in front of them. The usual equipment here is an incline, sufficiently long enough, to accommodate several coils, which are blocked from rolling down, in one manner or another. When the machine in question is ready for another coil, the block is removed, and the coil allowed to roll down into the coil box, or space for feeding. The increase in weight of coils, makes this method less easily handled, and the introduction of a very slight inclined conveyor, controlled by brakes onto a tilter, accommodates the handling of these coils with much greater facility.

The use of belt conveyors has found a convenient place in individual sheet handling, feeding skin mills or from skin mills to roller levellers eliminating the possible hazards of exposed sheet surfaces from scratches that might develop in conveying by other means.

Jib cranes work out as a convenience, if the service where they are needed, permits locating near building columns or a wall where their operation can be carried on without conflict with overhead cranes. Either manually operated, or powered electrically, they often accommodate a situation to facilitate a service which would normally require crane service, which is not at all times regularly dependable, because of the conflict with other required crane demands.

The brunt of the material handling work in the cold strip mill, falls on tractors of the various types previously named. The flexibility, latitude of travel, and rapidity, with which these machines serve, has been an all important aid to large production through processing machines at the least cost. Although the motivating power may be either one of the three previously mentioned, the last two, namely gas electric or straight electric, powered by storage battery, are by far the most popular.

Discussion of the relative merits of each type as to the reliability, economy, and general performance, might well follow here, but this would require considerable time and space; in fact sufficient in itself to merit a paper before this society on the subject alone. In a few words, it would seem that each type has its place in the business. For heavy capacities where operations require a fast pace, constantly over a wide range of operation, from some angles it would appear that the gas electric, should get the call, but on the other hand, this type appears to suffer more from high maintenance costs, which I believe may be attributed to operation which in turn reflects upon control. Young men appear to make the best operators of tractors, but usually along with that valuable quality of alertness and cleverness of operation, comes carelessness. Controls that can be governed dependably by equipment, that cannot readily be tampered with, will do much I believe to relieve maintenance costs of gas electric tractors.

**Straddle type tractor picking up load from roller conveyor.**

The ram type of tractor is the most popular in the cold strip mills, and are now being built to handle coils as heavy as 16,000 lbs. Ram tractors supply the cold reducing mills with coils, and take them from the tension reels to the next processing. Since the cold reducing units are the main processing machines in the cold strip mill, then this service becomes the one of most importance in material handling equipment. Four of these machines have been known to supply, and take away from one cold reducing unit 887,000 lbs. in a period of eight hours,—two supplying the mill, and two taking from the mill to the next process.

In the sheet form, the material is handled by the straddle type tractor, or fork type tractors. In the wide strip mills the fork type runs afoul of the same objections as found in the hot mill. The weight of the lift, and dimensions, makes design and maneuverability conflict.

The straddle type serves adequately to a degree, but the limitation of lift, and the necessary dimensions of the machine capable of handling wide sheets, are somewhat against its use.

Towing tractors find a good application in handling trucks about the department. Trucks can be loaded and accumulated at any one point in the processing and coupled together, and transferred to other places with this machine. The old experience of seeing a group of men pulling and pushing a hand truck, loaded with sheets, is now an unusual sight, and one man operating a towing truck, takes care of the situation easily and economically.

The loading of box cars is now handled with a minimum of hand labor by the employment of straddle type sheet loading tractors, and the articulated platform type sheet loaders. The restricted confines of a box car, require an unusual degree of maneuverability of any machine designed for this job, and the floor construction is not adequate for concentrated heavy wheel loads, but these machines have vastly improved the situation, although I believe that there is still opportunity for manufacturers in this field of equipment to go further.

The great range of tractors from every consideration has brought them into a position where they are definitely indispensable to strip business. The manufacturers are to be congratulated on the progress made in steel plant adaptation, in such a relatively short period.

With the great many valuable and different types of material handling facilities in these mills, to get the best return for the capital expended, must come the proper coordination. Most of this equipment depends on good operators to obtain its best return, for not only does speed of operation, and maintenance of the equipment, depend on the operator, but also much to preserve quality. Every time a coil, or pack, is transported from one location to another, one or more seconds—or waster sheets, is a potential possibility. All strip manufacturers are well aware of the penalty of the high percentage of wasters, the elimination of which means the merchandising of more primes. To properly get the best benefits from the present up to date handling facilities, and to prevent damage to material, providing a sufficient volume exists,—I consider it good economy to employ active supervision over this field alone. With rapidly moving material the possibility of damage continually exists in small amounts at a time, day in and week out. The prevention of a fractional part of it would pay well for good supervision.

As you have no doubt observed in this rather general discussion of the subject, the writer has not attempted to dwell on detail, or a technical description of equipment, the main desire has been to touch on points here and there, and mainly bring out that the handling is an expensive business, and that scientific minds are going forward with more, and better application, which its magnitude so definitely demands.

# DISCUSSION

PRESENTED BY

G. S. WARREN, Chief Engineer, Sharon Steel Corporation, Sharon, Pa.
J. H. VOHR, Superintendent Strip Mills, Granite City Steel Co., Granite City, Illinois.

*G. S. Warren:* Mr. Gillies has given us a very fine description of the different types of Material Handling Equipment and has shown us when the different types can be used to the best advantage, in the wide strip and Sheet Mills, for handling in production, between different operations and the final loading of the material into the cars for shipping.

Most of the material handling equipment was developed in the narrow strip mills, says from $3/8''$ to $24''$ wide, and for the wide strip and sheet mills, it was only necessary to increase the capacities of the different units.

The problems of handling the narrow strip are greater than those of the wide strip mills as it is necessary to hand handle the small packages and also to be equipped to mechanical handle the large packages. The safety features is also more difficult, as the narrow coils are dangerous to handle due to the fact that they upset easily and the narrow flat strip has to be carefully piled or it is falling on the feet of the men. There are a lot of foot accidents in handling narrow strip, due principally to the carelessness of the men, as the Steel Co's. have installed very complete safety devices and have tried to educate the men to be careful.

Another problem of the narrow strip mills is the great number of different types of packages that are required by the customers, which in turn, requires a greater variety of mechanical handling equipment. Some of the customers want short coils, other want coils as long as they can get them, some want them loaded in the cars flat, others on edge. Some of the coils have to be put on wooden platforms, and strapped to same, so that a lift tractor can pick them up. A good many narrow Cold Roll coils have to be boxed. One customer even required the Cold Roll coils to be loaded in special kegs. The narrow flat strip has to be bundled, some with wire, some with flat bands. Each customer wants a special number of pieces in his bundles. In fact the detail requirements of packing and loading narrow strip are all out of reason due to the fact that no two customers have the same equipment for unloading and handling the strip to their machines.

For handling the products of the wide Strip Mills, the customers have had to install the proper unloading equipment so that the loading is practically standard and therefore simplifies their loading equipment.

The greatest improvement in loading strip and Sheets into box cars could be made by the use of a box car with a removable roof, as all of the steel mills would have cranes available and a good many of the customers have cranes for unloading. In spite of the fact that there has been some very fine machines built for unloading steel into box cars, there is a lot of lost time getting in and out of the cars, due to the limited space.

*J. H. Vohr:* It is gratifying to hear of the importance which Mr. Gillies attaches to the problem of his subject. All of us can easily recall that not so many years ago the handling of material received minor attention from the higher executives, their viewpoint, at least to my observation, being to merely put on another man or two.

Of course, this viewpoint is readily understandable when we consider the change in conditions from twenty years ago. At that time all of our material was handled either by push and pull tractors or overhead cranes. Such pieces of equipment as specially designed tractors, power driven conveyors, gravity conveyors, etc., were non-existent, at least at steel mills.

I would like to add emphasis to the statements made by Mr. Gillies in regard to present-day equipment being so designed as to handle considerably greater loads than just a few years ago. I recall that five years ago our largest coil weighed 5100 pounds. Today, with the same mill machinery, coils are being produced weighing 20,000 pounds. Still the material handling equipment is not comparatively stronger than that used for the smaller coils.

We engineers are somewhat at fault for the lighter design. Original costs are of extreme importance, and there is a strong tendency for us not to pay the price for the extra pig iron.

We have Mr. Gillies to thank for a very interesting and instructive paper.

# Developments

# IN ROLLING FLAT STEEL PRODUCTS IN 1936

By STEPHEN BADLAM
Consulting Engineer
PITTSBURGH, PA.

**Presented before the Annual Convention of the A. I. & S. E., Detroit, Michigan, September 22-25, 1936**

## INTRODUCTORY

▲ ON the 26th. of November, 1926, the Butler Mill of the then Columbia Steel Company, and now the Columbia Division of The American Rolling Mill Company, went into operation.

Some three years previously, in January, 1924, the Ashland Mill of The American Rolling Mill Company had demonstrated the commercial practicability of hot rolling wide, thin, flat material, by a continuous process, in lengths which were a multiple of usual sheet lengths. The Butler Mill, in addition, by the application of strip rolling practice to sheet widths, and particularly by the processing of the material in coils, became the prototype of the present day mills for the rolling of wide, thin, flat material. There is in fact, today a tendency to revert quite closely to the original Butler type, three of the latest mills designed being provided with a roughing stand in which several passes are taken.

November, 1936, therefore, marks the tenth anniversary of the beginning of the system of Broad Strip Rolling.

## GROWTH OF BROAD STRIP ROLLING

The growth of the Broad Strip Mill, since 1926, has been phenomenal. The productive capacity has been increased at a rate unprecedented in the history of the rolling mill, the average increase in capacity, for the ten years, being at the rate of 1,000,000 tons per year. The greatest increase has been in 1935–6–7, with approximately 2,500,000 tons added for each of the three years. The additions to the capacity, by years, is shown in the table following:

## CONTINUOUS SHEET AND HOT BROAD STRIP MILLS

### INCREASE IN CAPACITY BY YEARS

| | | Added During Year | | |
|---|---|---|---|---|
| Year | Capacity Jan. 1 | No. of Mills | Capacity | Revision of Previous Figures |
| 1924 | ........ | 1 | 180,000 | |
| 1925 | 180,000 | .. | ........ | |
| 1926 | 180,000 | 1 | 180,000 | |
| 1927 | 360,000 | 3 | 900,000 | |
| 1928 | 1,260,000 | 1 | 266,000 | |
| 1929 | 1,526,000 | 1 | 289,000 | |
| 1930 | 1,815,000 | 1 | 400,000 | 330,000 |
| 1931 | 2,545,000 | 1 | 480,000 | |
| 1932 | 3,025,000 | 3 | 1,250,000 | |
| 1933 | 4,275,000 | .. | ........ | |
| 1934 | 4,275,000 | .. | ........ | |
| 1935 | 4,275,000 | 5 | 2,206,000 | 882,500 |
| 1936 | 7,363,500 | 4 | 2,480,000 | |
| 1937 | 9,843,500(est.) | 4 | 2,400,000 | |
| Total to Jan. 1, 1938 | | 25 | 12,243,500 | |

## 1935-1936 CONSTRUCTION

Of the five Hot Broad Strip Mills, reported as being under construction, last year, The Bethlehem Steel Co., 79″ Mill at Lackawanna, N. Y., went into operation on Dec. 29th., 1935. The Carnegie-Illinois Steel Co., 80″ Mill, at Gary, Ind., (previously reported as American Sheet & Tin Plate Co.,), on Mar. 1st. 1936, and the Great Lakes Steel Corp'n., 96″ Mill at Ecorse, Mich., (previously listed as 79″ Mill), on Mar. 23d., 1936. The Carnegie-Illinois Steel Co., 100″ Mill, at Homestead, Pa., went into operation on Dec. 3, 1936, and the Granite City Steel Co., 90″ mill, (previously reported as 84″ Mill), is expected to go into operation shortly.

The Jones & Laughlin Steel Corp'n., 96″ Mill, the announcement of which was made in December, 1935, is now well along towards completion, and may be expected to start operation early in January, 1937.

### 1937 CONSTRUCTION

There are, furthermore, three additional Broad Strip Mills, the official announcement of which have been made during the last three months, and all of which are scheduled for operation late in 1937.

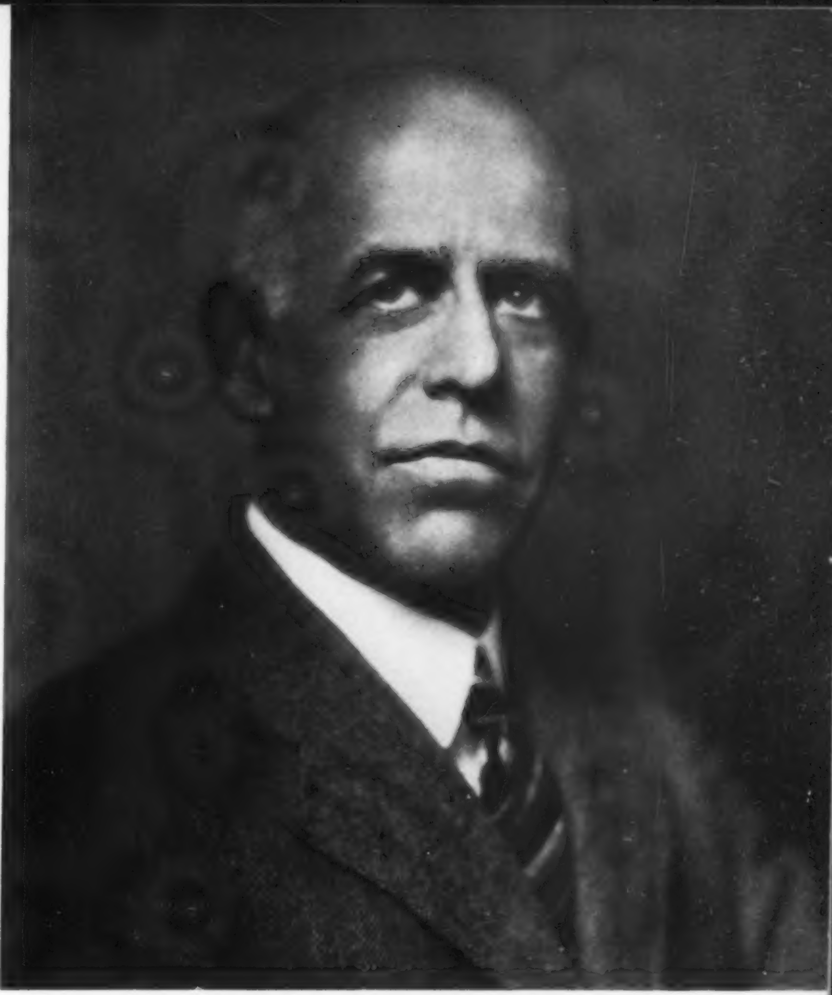
Tennessee Coal Iron & R.R. Co. Fairfield, Ala. . 48″
Republic Steel Corp'n., Cleveland, Ohio . . . . . . 98″
Bethlehem Steel Co., Sparrows Point, Md. . . . . 56″

### PRESENT STATUS

The present status of the Continuous Sheet, and Broad Strip Mills, now either in operation, under construction, or authorized, in the United States, is shown in the following table, in which are tabulated, in chronological order, the name of the operating company, the location, size, total main roll connected H.P. rated annual capacity, and date of operation.

### CAPACITY

As indicated in the following table, there are now in operation, in the United States, twenty one Continuous Mills, for the hot rolling of wide, thin, flat



STEPHEN BADLAM

### TABLE 1

### CONTINUOUS SHEET AND HOT BROAD STRIP MILLS IN THE UNITED STATES

| No. | Operated By | Location | Size | Conn. HP | Annual Capacity | F.O. |
|---|---|---|---|---|---|---|
| 1 | American Rolling Mill Co. | Ashland, Ky. | 58″ | 12,800 | 432,000 | 1924 |
| 2 | American Rolling Mill Co. | Butler, Pa. | 48″ | 13,000 | 312,500 | 1926 |
| 3 | Republic Steel Corp'n. | Warren, O. | 36″ | 13,000 | 302,000 | 1927 |
| 4 | Weirton Steel Co. | Weirton, W. Va. | 54″ | 16,600 | 420,000 | 1927 |
| 5 | Carnegie-Illinois Steel Corp'n. | Gary, Ind. | 42″ | 19,550 | 400,000 | 1927 |
| 6 | American Rolling Mill Co. | Middletown, O. | 80″ | 25,800 | 372,000 | 1928 |
| 7 | Wheeling Steel Corp'n. | Steubenville, O. | 60″ | 25,650 | 540,000 | 1929 |
| 8 | Great Lakes Steel Corp'n. | Ecorse, Mich. | 38″ | 20,150 | 400,000 | 1930 |
| 9 | Carnegie-Illinois Steel Corp'n. | So. Chicago, Ill. | 96″ | 26,800 | 720,000 | 1931 |
| 10 | Otis Steel Co. | Cleveland, O. | 72″ | 24,650 | 375,000 | 1932 |
| 11 | Inland Steel Co. | Indiana Harbor, Ind. | 79″ | 34,950 | 600,000 | 1932 |
| 12 | Allegheny Steel Co. | Brackenridge, Pa. | 38″ | 13,150 | 275,000 | 1932 |
| 13 | Youngstown Sheet & Tube Co. | Campbell, O. | 79″ | 37,450 | 536,000 | 1935 |
| 14 | Carnegie-Illinois Steel Corp'n. | Gary, Ind. | 38″ | 24,800 | 270,000 | 1935 |
| 15 | Ford Motor Co. | Dearborn, Mich. | 56″ | 27,050 | 500,000 | 1935 |
| 16 | Carnegie-Illinois Steel Corp'n. | McDonald, O. | 43″ | 30,400 | 300,000 | 1935 |
| 17 | Bethlehem Steel Co. | Lackawanna, N. Y. | 79″ | 35,950 | 600,000 | 1935 |
| 18 | Carnegie-Illinois Steel Corp'n. | Gary, Ind. | 80″ | 42,600 | 720,000 | 1936 |
| 19 | Great Lakes Steel Corp'n. | Ecorse, Mich. | 96″ | 39,450 | 720,000 | 1936 |
| 20 | Granite City Steel Co. | Granite City, Ill. | 90″ | 18,050 | 320,000 | 1936 |
| 21 | Carnegie-Illinois Steel Corp'n. | Homestead, Pa. | 100″ | 33,100 | 729,000 | 1936 |
| 22 | Jones & Laughlin Steel Corp'n. | Pittsburgh, Pa. | 96″ | 39,450 | 720,000 | 1937 |
| 23 | Tennessee C. I. & R. R. Co. | Fairfield, Ala. | 48″ | . . . . . . | 360,000 | 1937 |
| 24 | Republic Steel Corp'n. | Cleveland, O. | 98″ | 39,950 | 720,000 | 1937 |
| 25 | Bethlehem Steel Co. | Sparrow's Point, Md. | 56″ | . . . . . . | 600,000 | 1937 |
|  | Total Annual Capacity |  |  |  | 12,243,500 |  |

rolled material, having an aggregate capacity of approximately 9,850,000 tons per annum. With the addition of the four mills, now under construction, or authorized, this figure will be increased to approximately 12,250,000 tons per annum.

## GEOGRAPHICAL DISTRIBUTION

Including the mills completed, under construction, and authorized, the geographical distribution will be as follows:

| District | No. of Mills | Annual Capacity |
|---|---|---|
| Eastern (Baltimore) District | 1 | 600,000 |
| Buffalo District | 1 | 600,000 |
| Pittsburgh District | 4 | 2,036,500 |
| Youngstown District | 3 | 1,138,000 |
| Cleveland District | 2 | 1,095,000 |
| Chicago District | 5 | 2,710,000 |
| Detroit District | 3 | 1,620,000 |
| Middletown-Ashland District | 2 | 804,000 |
| Steubenville-Weirton District | 2 | 960,000 |
| St. Louis District | 1 | 320,000 |
| Southern (Birmingham District) | 1 | 360,000 |
| TOTAL | 25 | 12,243,500 |

## DESCRIPTION OF MILLS

Descriptions and illustrations of most of the mills which were placed in operation during 1935 and 1936, have already appeared in the trade publications, and, for that reason, no detailed descriptions will be included in the present paper.

Complete descriptions of the following mills have appeared in the Iron and Steel Engineer.

| | |
|---|---|
| Carnegie-Illinois Steel Corp'n., McDonald, O. | April 1936 |
| Ford Motor Co., Dearborn, Mich. | Sept. 1936 |
| Great Lakes Steel Corp'n., Ecorse, Mich. | Sept. 1936 |

## BETHLEHEM STEEL CO.

## LACKAWANNA PLANT, LACKAWANNA, N. Y.

### 79″ Broad Strip Mill

A description of this installation appeared in the trade papers early last year. An inspection trip to the Lackawanna Plant is, moreover, scheduled for the spring meeting of the Association, on April 29, 1937, at which time a very complete description of the mill may be expected. For these reasons no description of this installation will be attempted at the present writing.

## CARNEGIE-ILLINOIS STEEL CORP'N

## GARY SHEET MILL, GARY, IND.

### 80″ Broad Strip Mill

No further information regarding this mill is available for publication at the present time.

## CARNEGIE-ILLINOIS STEEL CORP'N

## HOMESTEAD WORKS, MUNHALL, PA.

### 100″ Cont. Plate Mill

A brief description of this mill was given in the paper of last year, and an inspection trip to the mill is scheduled for July, 1937, at which time we may expect a complete description.

## GRANITE CITY STEEL CO.

## GRANITE CITY, ILL.

### 90″ Broad Strip Mill

The new 90″ hot strip mill, of the Granite City Steel Co., represents a type of mill in which considerable interest is being shown at the present time, that is to say, in which the attempt is made to secure the greater part of the advantages possessed by the most complete type of Broad Strip Mill, illustrated by the Great Lakes Steel Co., mill, at an expenditure of only a fraction of the capital investment of these mills.

The Granite City mill utilizes two existing plate mills, the one a two high reversing, steam driven, mill, with rolls 30″ x 96″, and the other a Lauth, three high, motor driven mill, with rolls 34″ and 22″ x 100″. To the first of these which serves as a slabbing mill, has been added a new vertical edging stand, with an independent motor drive of 1000 H.P., 300/600 R.P.M., and a new slab shear.

Following the shear, there has been installed one continuous slab heating furnace, room being left for a second, and a two high scale breaker stand, (formerly a jobbing mill stand), with a new 700 H.P. 505 R.P.M. motor drive.

Next in line comes the three high plate mill, driven by the original 3000 H.P. 236 R.P.M. motor. Following and immediately adjacent to the three high stand is a new vertical edger, the two together serving as a roughing stand, in which several passes will be taken.

At a distance of about 120 feet from the three high stand is located the new finishing train comprising a second two high scale breaker, driven by a 350 H.P. 450/900 R.P.M. motor, and four, four high stands with rolls 25″ and 53″ x 90″. equipped with Morgoil bearings on the backing rolls. The first three stands are driven by 3—3500 H.P. 175/350 R.P.M. motors and the last, or finishing stand, by a 2500 H.P., 225/450 R.P.M. motor. The second scale breaker, and the four finishing stand motors, are fed from two 5000 KW., 600 V., D.C. synchronous motor-generator sets.

Beyond the last finishing stand there are, in line, a runout table, up-coiler, pinch rolls, flying shear and sheet piler. Intermediate the finishing stand and the coiler, there is provided a lateral plate transfer, leading to a parallel cooling conveyor, with the usual edge trimmer, plate shears, leveler ,and loading table.

It is expected that the mill will be able to roll plates to 84″ in width, in gages from $\frac{3}{16}$″ to ¾″, strip to 72″ in width, in gages of No. 12, and heavier, and lighter gages in somewhat reduced widths. The initial capacity is estimated at 300,000 tons per year.

## JONES & LAUGHLIN STEEL CORP'N

## PITTSBURGH, PA.

### 96" Broad Strip Mill

The new 96" Broad Strip Mill, of the Jones & Laughlin Steel Corp'n., which is now approaching completion, will, in all essential characteristics, be a duplicate of the Great Lakes Steel Corp'n. mill, a complete description of which appeared in the Sept. 1936 issue of the Iron and Steel Engineer.

This mill is located in the Hazelwood District, Pittsburgh, Pa., and represents the most important piece of steel plant construction, within the city limits, that has been made within recent years.

Slabs for the new mill will be produced at the South Side Works, (directly across the river), on the new Blooming Mill which was completed about a year ago.

## TENNESSEE COAL IRON & R. R. CO.

## FAIRFIELD WORKS, FAIRFIELD, ALA.

### 48" Broad Strip Mill

Announcement has been made that work will proceed at once upon a development program, which will include, a new Blooming Mill, a 48" Hot Strip Mill, having an annual capacity of 300,000 tons, two continuous cold rolling mills, one for sheets, and one for strip for tinning, and having a combined capacity of 200,000 tons, and a tinning plant having a capacity of 4,000,000 base boxes, annually.

It is estimated that, with the completion of the new mills, approximately 2500 men will be added to the 17,000 now employed in the district.

## BETHLEHEM STEEL CO.

## MARYLAND PLANT, SPARROWS POINT, MD.

### 56" Broad Strip Mill

It was recently announced that $35,000,000 will be spent upon new construction at the Maryland Plant of the Bethlehem Steel Co., during the coming year. This is in continuation of the program initiated in 1935, and upon which $34,500,000 has been expended to date.

Included in the new construction will be a 56" Continuous Hot Strip Mill, having an annual capacity of 600,000 tons, in widths to 48", and in gages from No. 20 up to ½". Complete hot and cold finishing equipment will be provided to meet the requirements for furniture, automobile, air-conditioning, and barrel stock, and for building materials.

The mill will also provide coils for the production of cold reduction tin plate, and the present equipment, for this purpose, will be supplemented by additional mills, and finishing equipment.

## REPUBLIC STEEL CORP'N.

## CORRIGAN-McKINNEY PLANT, CLEVELAND, O.

### 98" Broad Strip Mill

The most recent announcement is that of the Republic Steel Corp'n., who are constructing a 98" Broad Strip Mill, at Cleveland, Ohio, upon a 120 acre tract, in the Cuyahoga River valley, adjoining the Wheeling and Lake Erie, and Newburgh and South Shore railroads, and adjacent to the Corrigan-McKinney Plant. Contracts for the buildings, furnaces, and machinery have been placed and it is expected that the mill will be in operation by the end of 1937.

The Hot Strip Mill will be designed for a capacity of 60/70,000 tons per month, (approximately 750,000 tons per year) in widths up to 90". It will include 10 main roll stands, driven by 4-3000 H.P., 5-4500 H.P., and 1-3500 H.P. motors. The finishing speed is reported as 2100 F.P.M.

The Cold Strip Mill will include one, or more, tandem trains, of three stands each, driven by 1-1500 H.P., and 2-2500 H.P. motors, and additional single stands, together with finishing equipment.

The buildings will comprise two main groups, the first, or Hot Mill group, covering an area of 315 feet x 1800 feet, and the second, or Cold Mill group, an area of 350 feet x 900 feet. The mills will be served by 21 cranes, ranging from 75 ton to 10 ton capacity. Since the first announcement was made, it was stated that a new Blooming Mill would also be built, to complete the installation, the ultimate cost of which is expected to exceed $15,000,000.

## FOREIGN CONSTRUCTION

## U. S. S. R., (RUSSIA)

In the paper of last year, mention was made of the mill of the Zaporojstal Works, U. S. S. R., as being the only plant of the Broad Strip Type, under construction, outside of the limits of the United States.

## VEREIGNIGTE STAHLWERKE

## DINSLAKEN, GERMANY

Since that time announcement has been made of the construction of a mill of the Broad Strip type by the Vereinigte Stahlwerke, at Dinslaken, Germany. This mill is of typical American design, but will be built complete abroad.

The mill consists of a four stand, two high roughing, so spaced that the piece is only in a single stand at the one time, followed by a two high scale breaker, and six four high finishing stands. The roll face is 1250 mm, (50").

## RICHARD THOMAS, LTD.

## EBBWVALE, SOUTH WALES, ENGLAND

### 56" Broad Strip Mill

A recent announcement has been made of the construction of a third plant, of similar type, by Richard Thomas, Ltd., Ebbwvale, South Wales, England. The installation will include, a Blooming Mill, and a Hot Strip Mill, both of the same size and design as the corresponding mills of the Ford Motor Co.

In addition to the hot strip mill there will be two tandem cold rolling mills, the one for sheets and the other for cold reduction tin plate, one cross rolling mill, for wide sheets, and the necessary skin rolling mills, and auxiliary equipment.

The contract for the machinery was recently placed with the United Engineering & Foundry Co., and a portion of the equipment will be built in this country, and a portion in England. The rated capacity will be 480,000 tons annually of hot rolled material, and 300,000 tons of cold rolled sheets, and strip for tinning.

## JAPAN

It is currently reported that the Kobe Steel Works, Kobe, Japan, have under consideration the construction of a Hot Broad Strip mill, of the American Type, and that this may be followed by a second mill, to be installed by the Japan Steel Co., but details are not available.

## COLD REDUCTION SHEET MILLS

There have been four complete installations, for the cold reduction of sheets, in wide widths, placed in operation during the year. Two installations were made in conjunction with new hot broad strip mills, at plants which had not previously produced this class of product.

The outstanding characteristics of the cold reduction sheet mills, installed during the past year, have been a marked increase in the speeds, and in the connected H.P., and in the improvement of the reels to permit such higher speeds, and also to increase the tension permissable without danger of buckling the interior wraps of the coil on the drum.

## GREAT LAKES STEEL CORP'N.

## ECORSE, MICH.

### Cold Strip Mill

The Great Lakes Steel Corp'n., through its affiliated company, The Michigan Steel Corp'n., had been a producer of sheets, in all grades, since 1923. It had also operated a 38″ Hot Strip Mill, since 1930, but until

**TABLE 2**

## CHARACTERISTICS OF MILLS AND DRIVES

### No. 1, 93″ TANDEM

| | Rolls | | | Motors | | | |
|---|---|---|---|---|---|---|---|
| Stand | Type | Dia. | Lgth. | H.P. | R.P.M. | Volt | Cur. |
| 1 | Hor. 4 Hi. | 24″ 49″ | 93″ | 1250 | 300/600 | 600 | DC |
| 2 | Hor. 4 Hi. | 24″ 49″ | 93″ | 1250 | 300/600 | 600 | DC |
| 3 | Hor. 4 Hi. | 24″ 49″ | 93″ | 1250 | 300/600 | 600 | DC |
| | Reel | | | 150/225 | 225/900 | 600 | DC |

### No. 2, 54″ TANDEM

| | Rolls | | | Motors | | | |
|---|---|---|---|---|---|---|---|
| Stand | Type | Dia. | Lgth. | H.P. | R.P.M. | Volt | Cur. |
| 1 | Hor. 4 Hi. | 20″ 49″ | 54″ | 1250 | 300/600 | 600 | DC |
| 2 | Hor. 4 Hi. | 20″ 49″ | 54″ | 1250 | 300/600 | 600 | DC |
| 3 | Hor. 4 Hi. | 20″ 49″ | 54″ | 1250 | 300/600 | 600 | DC |
| | Reel | | | 150/225 | 225/900 | 600 | DC |

### MOTOR-GENERATOR SET

Motor: 8500 HP, PF, 360 RPM, 6600 V. 60 Cy. Syn.
Gen: 2-3000 KW., 600 V, DC.

### No. 3, 93″ SINGLE

| | Rolls | | | Motors | | | |
|---|---|---|---|---|---|---|---|
| Stand | Type | Dia. | Lgth. | H.P. | R.P.M. | Volt | Cur. |
| | Hor. 4 Hi. | 24″ 49″ | 93″ | 1250 | 300/600 | 600 | DC |
| | Reel | | | 150/225 | 225/600 | 600 | DC |

### No. 4, 93″ SINGLE

| | Rolls | | | Motors | | | |
|---|---|---|---|---|---|---|---|
| Stand | Type | Dia. | Lgth. | H.P. | R.P.M. | Volt | Cur. |
| | Hor. 4 Hi. | 24″ 49″ | 93″ | 1250 | 300/600 | 600 | DC |

### No. 5, 54″ SINGLE

| | Rolls | | | Motors | | | |
|---|---|---|---|---|---|---|---|
| Stand | Type | Dia. | Lgth. | H.P. | R.P.M. | Volt | Cur. |
| | Hor. 2 Hi. | 27″ | 54″ | 250 | 500/1000 | 230 | DC |
| | Reel | | | 60/125 | 225/900 | 230 | DC |

### MOTOR-GENERATOR SET

Motor: 4000 HP, PF, 720 RPM. 6600 V, 60 Cy, Syn.
Gen: 2-1250 KW, 600 V, DC. 1- 300 KW, 250 V, DC.

early last year had not been a producer of cold rolled strip, or of sheets, by the cold reduction method. Another affiliated company, The Weirton Steel Co., however, for many years, been among the largest producers of both strip and sheets by cold reduction methods.

The Great Lakes Steel Corp'n., in connection with the Hot Broad Strip Mill, which was placed in operation in March 1936, also installed a complete cold strip rolling plant capable of producing sheets in widths up to the greatest produced by any company, 90″. The cold rolling plant includes:

One 93″ 3 stand, 4 High, Tandem
One 54″ 3 stand, 4 High, Tandem
One 93″ single, 4 High, with reel
One 93″ single, 4 High, without reel
One 54″ single, 2 High, with reel

See Table No. 2

## BETHLEHEM STEEL CO.

## LACKAWANNA PLANT, LACKAWANNA, N. Y.

### Cold Strip Mill

The Bethlehem Steel Co., had owned and operated the plant of the Seneca Iron & Steel Co., at Blasdell, N. Y., for some years, but had not made strip or sheet steel at the Lackawanna Plant until last year.

In conjunction with the Hot Broad Strip Mill, which went into operation on Dec. 29, 1935, there was also installed a complete cold strip installation comprising:

One 75″ 3 stand, 4 High Tandem
One 54″ 3 stand, 4 High Tandem
One 93″ single, 4 High cross rolling stand
One 75″ single, 4 High, with reel
One 75″ single, 4 High, without reel
One 54″ single, 2 High, with reel

See Table No. 3.

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**TABLE**
**3**

### CHARACTERISTICS OF MILLS AND DRIVES

### No. 1, 75″ TANDEM

| | | Rolls | | | | | Motors | | |
|---|---|---|---|---|---|---|---|---|---|
| Stand | Type | Dia. | | Lgth. | F.P.M. | H.P. | R.P.M. | Volt | Cur. |
| 1 | Hor. 4 Hi. | 20″ | 49″ | 75″ | | 1250 | 300/600 | 600 | DC |
| 2 | Hor. 4 Hi. | 20″ | 49″ | 75″ | | 1250 | 300/600 | 600 | DC |
| 3 | Hor. 4 Hi. | 20″ | 49″ | 75″ | | 1250 | 300/600 | 600 | DC |
| | Reel | | | | | 150/225 | 225/900 | 600 | DC |

### No. 2, 54″ TANDEM

| Stand | Type | Dia. | | Lgth. | F.P.M. | H.P. | R.P.M. | Volt | Cur. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Hor. 4 Hi. | 20″ | 49″ | 54″ | | 1250 | 300/600 | 600 | DC |
| 2 | Hor. 4 Hi. | 20″ | 49″ | 54″ | | 1250 | 300/600 | 600 | DC |
| 3 | Hor. 4 Hi. | 20″ | 49″ | 54″ | | 1250 | 300/600 | 600 | DC |
| | Reel | | | | | 150/225 | 225/900 | 600 | DC |

### MOTOR-GENERATOR SET

Motor: 8500 HP, 1.0 PF, 500 RPM, 6600 V, 25 Cy, Syn.
Gen: 2-3000 KW, 600 V, DC.

### No. 3, 75″ SINGLE

| Stand | Type | Dia. | | Lgth. | F.P.M. | H.P. | R.P.M. | Volt | Cur. |
|---|---|---|---|---|---|---|---|---|---|
| | Hor. 4 Hi. | 20″ | 49″ | 75″ | | 1250 | 300/600 | 600 | DC |
| | Reel | | | | | 150/225 | 225/900 | 600 | DC |

### No. 4, 75″ SINGLE

| Stand | Type | Dia. | | Lgth. | F.P.M. | H.P. | R.P.M. | Volt | Cur. |
|---|---|---|---|---|---|---|---|---|---|
| | Hor. 4 Hi. | 20″ | 49″ | 75″ | | 1250 | 300/600 | 600 | DC |

### MOTOR-GENERATOR SET

Motor: 4000 HP, 1.0 PF, 500 RPM, 6600 V, 25 Cy, Syn.
Gen: 2-1250 KW, 600 V, DC.

### No. 5, 93″ SINGLE

| Stand | Type | Dia. | | Lgth. | F.P.M. | H.P. | R.P.M. | Volt | Cur. |
|---|---|---|---|---|---|---|---|---|---|
| | Hor. 4 Hi. | 24″ | 49″ | 93″ | | 1250 | 300/600 | 600 | DC |

### No. 6, 54″ SINGLE

| Stand | Type | Dia. | | Lgth. | F.P.M. | H.P. | R.P.M. | Volt | Cur. |
|---|---|---|---|---|---|---|---|---|---|
| | Hor. 2 Hi. | 28″ | | 55″ | | 250 | 500/1000 | 230 | DC |
| | Reel | | | | | 60/125 | 225/900 | 230 | DC |

### MOTOR-GENERATOR SET

Motor: 2000 HP, 1.0 PF, 750 RPM, 6600 V, 25 Cy, Syn.
Gen: 2-500 KW, 300 V, DC. 1-300 KW, 250 V, DC.

## AMERICAN ROLLING MILL CO.

## MIDDLETOWN, OHIO

### 80″ Cold Strip Mill

During the past year the American Rolling Mill Co., has installed, and placed in operation, a three stand 80″ tandem, cold strip mill, designed particularly for the production of auto-body, and similar sheets in widths up to 74″.

In order to furnish the necessary hot rolled stock, in the widths desired, the hot strip mill built in 1928, has been widened to 80″, one additional stand, and one new motor provided, and extensions and improvements made in the coil handling facilities. Included in the latter is a coil build-up unit comprising decoiler, shear, 1200 KVA flash buttwelder, flash trimmer and recoiler, By this means several coils, as rolled on the hot mill, may be welded end to end to form a longer and heavier coil. A maximum of six coils may be thus united to form a single coil, 74″ wide, by .090″ thick, and having a total length of 1200 feet, and a weight of 27,000 lbs.

A new continuous strip pickler has been provided. consisting, first of a decoiler, shear, and stitcher. Next in line is a pinch roll and looping pit, followed by the pickling tanks the bottoms of which are four feet above the mill floor for purposes of inspection and repairs. There are four 50 foot rubber and brick lined steel tanks, for acid, and two 30-foot steel tanks for wash water, and a hot air dryer. At the delivery end of the pickling unit there is a second set of pinch rolls, a shear for removing the stitch, and a recoiler.

The cold strip mill proper, which is illustrated in Figures 1–2, comprises three stands of four high rolls, arranged in tandem. Preceding the first stand there is a decoiler and an automatic device for entering the front end of the piece into the first stand of the mill.

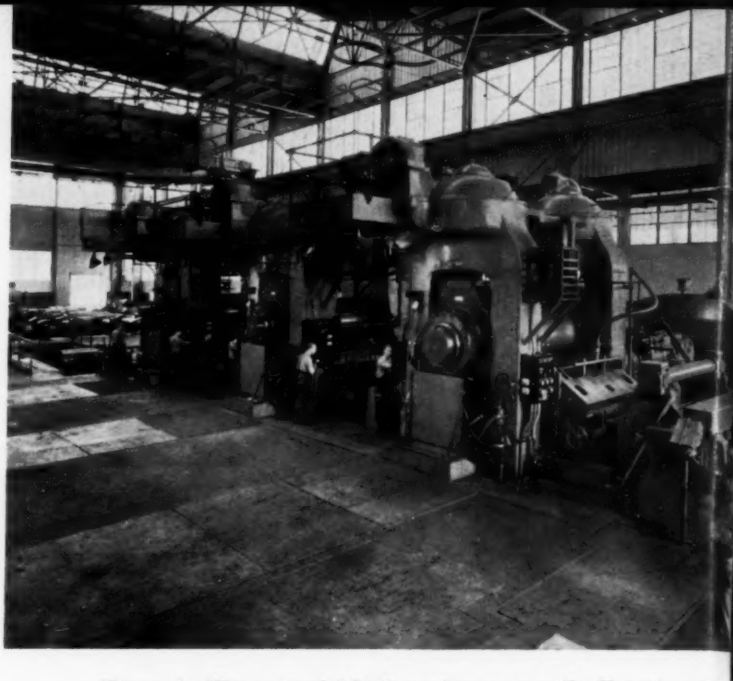


Figure 1—Three stand-4 high tandem strip mill—Entering side
The American Rolling Mill Company, Middletown, Ohio.

Following the last stand there is an automatic gager, and the tension reel.

In addition to the three stand tandem mill, for reduction rolling, there is a single stand mill for skin pass, or temper pass, rolling, in coils, after annealing.

The backing rolls in all stands are equipped with oil lubricated sleeve type bearings, (Morgoil), while the working rolls are equipped with roller bearings.

In the annealing department there are eighteen bell-type furnaces of the vertical radiant tube type, with the necessary bases, and inner covers of special heat resisting alloy. All are pyrometrically controlled and

TABLE 4

### CHARACTERISTICS OF MILLS AND DRIVES

### 80″ THREE STAND TANDEM

| | Rolls | | | | | Motors | | | |
|---|---|---|---|---|---|---|---|---|---|
| Stand | Type | Dia. | | Lgth. | F.P.M. | H.P. | R.P.M. | Volt | Cur. |
| 1 | Hor. 4 Hi. | 19″ | 49″ | 80″ | 200–400 | 1500 | 300–600 | 600 | DC |
| 2 | Hor. 4 Hi. | 19″ | 49″ | 80″ | 250–500 | 1500 | 300–600 | 600 | DC |
| 3 | Hor. 4 Hi. | 19″ | 49″ | 80″ | 300–600 | 1500 | 300–600 | 600 | DC |
| | Reel | | | | | 600 | 300–1050 | 600 | DC |

### MOTOR-GENERATOR SET

Motor: 5750 HP, .8 PF, 514 RPM, 6600 V, 60 Cy, Syn.
Gen: 2-2000 KW, 600 V, DC.

### 58″ SINGLE MILL

| | Rolls | | | | | Motors | | | |
|---|---|---|---|---|---|---|---|---|---|
| Stand | Type | Dia. | | Lgth. | F.P.M. | H.P. | R.P.M. | Volt | Cur. |
| | Hor. 3 Hi. | 14″ | 27″ | 58″ | 400 | 150 | 550 | 230 | DC |
| | Reel | | | | | 150 | 300/1200 | 230 | DC |

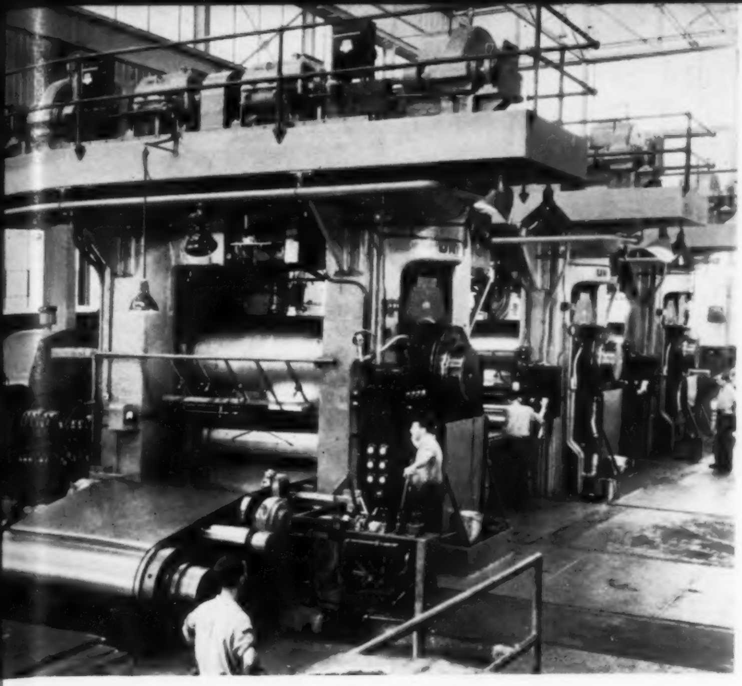


Figure 2—Three stand-4 high tandem strip mill—Delivery side. The American Rolling Mill Company, Middletown, Ohio.

recording instruments are provided giving readings at five different points in the charge.

The cold rolled product from the tandem reduction mill may be annealed in coils, for temper rolling on the three high mill, or, if desired, may be side trimmed and cut to length, and annealed in packs, in which case the individual sheets are temper rolled on the regular two high sheet mill cold rolls.

## CARNEGIE-ILLINOIS STEEL CORP'N.

## GARY SHEET MILLS, GARY, IND.

The fourth installation, that of the Carnegie-Illinois Steel Corp'n., (Formerly American Sheet & Tin Plate Co.,) Gary Sheet Mills, will be operated in conjunction with the new 80″ Hot Broad Strip Mill, which went into operation in March of the past year. The new cold rolling equipment will supplement existing cold reduction mills, which previously had operated on wide hot rolled strip procured from other sources.

Including the additions made during the past year, the installation will include:

One 84″ Single, 4 High, Reversing
One 72″ Single, 4 High, Reversing
One 84″ 3 stand, 4 High, Tandem
One 84″ Single, 4 High, without reel
Four 84″ Single ,4 High, with reels
Two 60″ Single, 4 High, with reels
One 84″ Single, 4 High, with reel (under const.)

The 84″, 3 stand, 4 high tandem mill is illustrated in Figure 3. The general characteristics of the 84″ Tandem, and the 72″ Reversing mills are given in table 5.

## YOUNGSTOWN SHEET & TUBE CO.

## CAMPBELL PLANT, CAMPBELL, O.

### Cold Strip Mill

The Youngstown Sheet & Tube Co., at the Campbell Plant, has completed, or under way, extensive additions

**TABLE**
**5**

### CHARACTERISTICS OF MILLS AND DRIVES

### No. 2, 72″ REVERSING

| | Rolls | | | | | Motors | | | |
|---|---|---|---|---|---|---|---|---|---|
| Stand | Type | Dia. | | Lgth. | F.P.M. | H.P. | R.P.M. | Volt | Cur. |
| | Reel | | | | | 1500 | 150/525 | 600 | DC |
| | Hor. 4 Hi. | 20½″ | 53″ | 72″ | 500/1000 | 4000 | 150/300 | 600 | DC |
| | Reel | | | | | 1500 | 150/525 | 600 | DC |

### No. 1, 84″ TANDEM

| Stand | Type | Dia. | | Lgth. | F.P.M. | H.P. | R.P.M. | Volt | Cur. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Hor. 4 Hi. | 20½″ | 56″ | 84″ | | 1500 | 200/400 | 600 | DC |
| 2 | Hor. 4 Hi. | 20½″ | 56″ | 84″ | | 2500 | 225/450 | 600 | DC |
| 3 | Hor. 4 Hi. | 20½″ | 56″ | 84″ | 265/530 | 2500 | 225/450 | 600 | DC |
| | Reel | | | | | 350 | 200/600 | 600 | DC |

### MOTOR-GENERATOR SET

Motor: 1-6500 KVA, 1.0 PF, 360 RPM, 660 V, 60 Cy.
Gen: 2-3000 KW, 600 V, DC. 2-125 KW, 230 V.

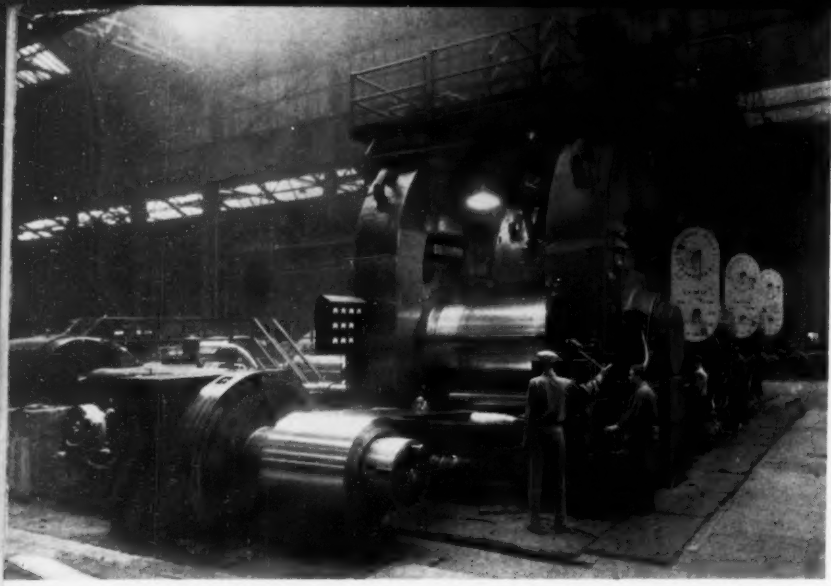


Figure 3—Three stand tandem, Cold Reduction Mill, Gary Sheet Mill.
Carnegie-Illinois Steel Corp, Gary, Ind.

to the capacity for cold reduction sheets, designed particularly to secure a better balance between the cold finishing capacity and the hot rolled capacity. There has been completed one additional skin rolling mill, and there is under construction, one three stand, 4 high, 54″ tandem mill. With the addition of these mills the cold rolling installation will include:

One 75″, 3 stand, 4 high, tandem
One 54″, 3 stand, 4 high, tandem
One 75″, single, 4 high
One 90″, single, 4 high, cross rolling mill
Two 54″, single, 2 high, skin rolling mills

There has also been provided, one additional continuous pickling line, additional normalizing furnaces, and annealing furnaces, and a new cold finishing building 120′ x 900′, housing the new equipment.

### PICKLING

Substantially all the new Broad Strip Mills have installed continuous pickling lines in connection with the cold rolling mills. As compared with the earlier continuous installations, the newer equipment is marked by an increase in the length of the acid tanks, making possible a higher speed through the pickler, and correspondingly greater capacity.

A new development that is particularly adapted to mills of smaller capacity, is a modification of the circular, mast type, pickler, and in which the coils are rotated while in the bath, thereby eliminating the danger of black spots, due to the wraps of the coil coming in contact. The acid is also caused to pass over the steel at a considerable velocity, by means of an impeller, and the action is thereby accelerated.

### ANNEALING

The progress in annealing has been largely in a further development of the means introduced during the past several years. The radiant tube type of annealing cover has come into greatly extended use, for example the entire equipment, other than the continuous normalizers, of the Bethlehem Steel Co., Broad Strip Mill, Lackawanna, N. Y., is of this type.

The Ford Motor Co., Dearborn, Mich., has installed a second continuous, roller hearth, controlled atmosphere, electrically heated furnace, 325 feet long, for bright annealing auto-body stock, in widths to 56″, and having a capacity of 7½ tons per hour. Normalized strip may be delivered to, and fabricated in, the body plant in strip form.

### STRIP FOR TINNING

There has been a very substantial increase, during the past year, in the number of mills for the production of strip for cold reduction tin plate.

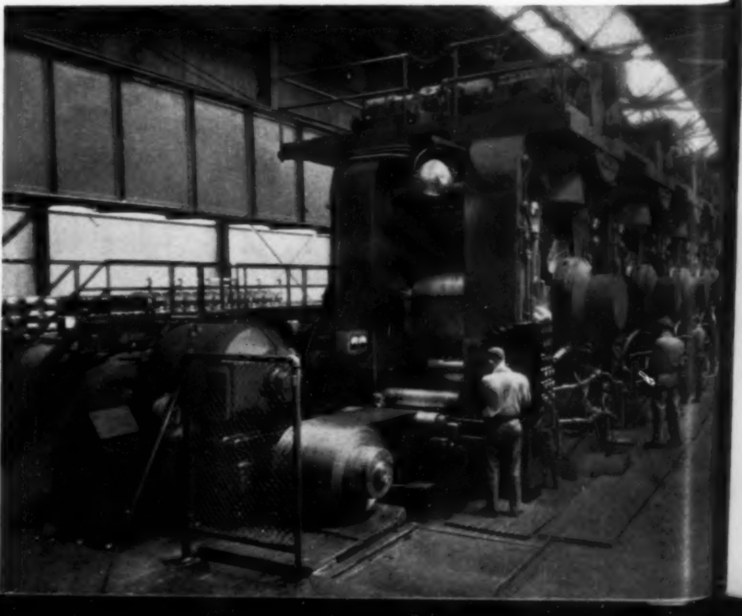
The five stand tandem mill, with two skin pass mills, of the Bethlehem Steel Co., at Sparrows Point, Md., the five stand tandem, (formerly rated as four stand), and one skin rolling mill, of the Crown Cork & Seal Co., Baltimore, Md., and the four stand tandem mill, (No. 5 Mill), of the Weirton Steel Co., at Weirton, W. Va., all went into operation during the second quarter of 1936.

### CARNEGIE-ILLINOIS STEEL CORP'N.

### GARY TIN MILL, GARY, IND.

The Carnegie-Illinois Steel Corp'n., placed in operation a five stand tandem mill, with two temper pass mills, in August, and have recently ordered a duplicate five stand mill, and three temper pass mills, which are expected to go into operation early in 1937. These two tandem trains are in addition to the two four high reversing mills which have been in operation since 1931, and 1934. The new tandem mills are illustrated in figure 4, and the characteristics of the mills are shown in the following table No. 6.

Figure 4—Five stand-Tandem Cold Reduction Mill—Gary Tin M
Carnegie-Illinois Steel Corp., Gary, Ind.



### REPUBLIC STEEL CORP'N.

### WARREN PLANT, WARREN, O.

The Republic Steel Corp'n., has placed in operation the second four high reversing mill, and a skin rolling mill at the Warren Plant. See Table No. 7. This mill is illustrated in Figure 5.

### REPUBLIC STEEL CORP'N.

### NILES PLANT, NILES, O.

At the Niles Plant a four stand, four high tandem mill is under construction and may be expected to go into production early in 1937. See Table No. 8.

### YOUNGSTOWN SHEET & TUBE CO.

### INDIANA HARBOR, IND.

The Youngstown Sheet & Tube Co., is adding to the Indiana Harbor Plant, one four high reversing mill, in general similar to the mill installed in 1934. It is also adding one four high skin rolling mill, equipped with tension devices on both sides of the rolls, in addition to the feed and winding reels.

### GRANITE CITY STEEL CO.

### GRANITE CITY, ILL.

The Granite City Steel Co., has installed an 18"-49" x 42", 4 high, reversing mill for the production of strip for tinning. It will utilize the product of the 90" Hot Strip Mill now under construction.

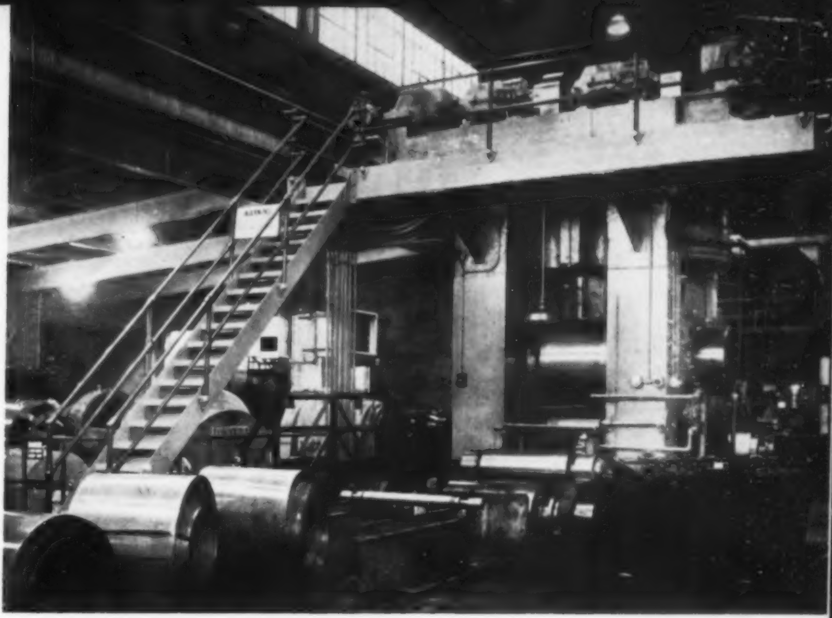


Figure 5—18-49" x 42" Single Reversing Mill, Republic Steel Corp., Warren, Ohio.

### DOMINION FOUNDRIES & STEEL LTD.

### HAMILTON, ONT.

The Dominion Foundries and Steel ,Ltd., has purchased one 16"-43" x 42", 4 High reversing cold strip

**TABLE 6** **CHARACTERISTICS OF MILLS AND DRIVES**

**42" Tandem**

| | | Rolls | | | Motors | | | |
|---|---|---|---|---|---|---|---|---|
| Stand | Type | Dia. | Lgth. | F.P.M. | H.P. | R.P.M. | Volt | Cur. |
| 1 | Hor. 4 Hi. | 20" 53" | 42" | | 500 | 400/800 | 600 | DC |
| 2 | Hor. 4 Hi. | 20" 53" | 42" | | 1250 | 300/600 | 600 | DC |
| 3 | Hor. 4 Hi. | 20" 53" | 42" | | 1250 | 300/600 | 600 | DC |
| 4 | Hor. 4 Hi. | 20" 53" | 42" | | 1250 | 300/600 | 600 | DC |
| 5 | Hor. 4 Hi. | 20" 53" | 42" | | 1250 | 300/600 | 600 | DC |
| | Reel | | | | 250 | 300/1200 | 600 | DC |

**MOTOR-GENERATOR SET**

Motor: 7050 HP, PF, 514 RPM, 6600 V, 60 Cy. Syn.
Gen: 2-2500 KW, 600 V, DC. 1-75 KW, 200 V. 1-100 KW, 250 V, DC, Exciter

**TABLE 7** **CHARACTERISTICS OF MILL AND DRIVE**

**42" Single Reversing**

| | | Rolls | | | Motors | | | |
|---|---|---|---|---|---|---|---|---|
| Stand | Type | Dia. | Lgth. | F.P.M. | H.P. | R.P.M. | Volt | Cur. |
| | Reel | | | | 300 | 300/1200 | 250 | DC |
| | Hor. 4 Hi. | 19" 49" | 42" | 500/1000 | 1200 | 400/800 | 250 | DC |
| | Reel | | | | 300 | 300/1200 | 250 | DC |

**MOTOR-GENERATOR SET**

Motor; 1450 HP, .8 PF, 720 RPM, 2200 V, 60 Cy.
Gen; 1000 KW, 250 V, DC.

**TABLE 8**

### CHARACTERISTICS OF MILL AND DRIVE

**42″ 4 Stand Tandem**

| | Rolls | | | Motors | | | |
|---|---|---|---|---|---|---|---|
| Stand | Type | Dia. | Lgth. | H.P. | R.P.M. | Volt | Cur. |
| 1 | Hor. 4 Hi. | 19″ 53″ | 42″ | 500 | 600/1200 | 600 | DC |
| 2 | Hor. 4 Hi. | 19″ 53″ | 42″ | 1000 | 400/800 | 600 | DC |
| 3 | Hor. 4 Hi. | 19″ 53″ | 42″ | 1000 | 400/800 | 600 | DC |
| 4 | Hor. 4 Hi. | 19″ 53″ | 42″ | 1500 | 300/600 | 600 | DC |
| | Reel | | | 250 | 300/1200 | 600 | DC |

**MOTOR-GENERATOR SET**

Motor: 5000 HP, PF, 514 RPM, 2200 V, 60 Cy. Syn.
Gen: 2-1750 KW, 600 V, DC.

mill for the production of tin plate strip. This mill will use the product of the universal plate mill, recently converted into a Steckel Hot Strip Mill, and will supplement a 24″ Steckel Cold Mill, which has been in operation for some time.

## WHEELING STEEL CORP'N

### YORKVILLE, OHIO

The Wheeling Steel Corp'n has under way a third 5 stand tandem train for strip for tinning. This mill, it is reported, will be equipped with 1-500 HP, 3-1000 HP, and 1-1250 HP motors.

## PITTSBURGH CRUCIBLE STEEL CO.

### MIDLAND, PA.

The Pittsburgh Crucible Steel Co., has under construction, a plant for the production of electro-tinned strip, in coils, which will include equipment of somewhat novel character. For the production of the steel base strip, they have purchased one four high reversing mill with rolls 12½″-34″ x 26″.

## TENNESSEE COAL IRON & R. R. CO.

### FAIRFIELD WORKS, FAIRFIELD, ALA.

Included in the program for improvements at the Fairfield Works of the Tennessee Coal Iron & R. R. Co., there will be one tandem mill, for the production of strip for tinning, together with a new tinning house. This will constitute the first plant for the production of tin plate in the South.

## BETHLEHEM STEEL CO.

### MARYLAND PLANT, SPARROW'S POINT MD.

The program for the improvements at the Sparrow's Point Plant will include additional capacity for the production of cold reduction tin plate, probably doubling the present capacity for this product.

## TECHNICAL FEATURES

The outstanding technical features of the new installations for the production of strip for tinning, are, like those for sheets, in the increased speeds, and in the improvements in the reels. In at least three of the more recent tandem mills. the maximum speed of finishing has been raised to 1250 to 1350 F.P.M., motors of 1000 to 1500 H.P. being provided, for mills having a roll face of 42″. The tendency may also be noted to use motors of different, and increasing H.P., for succeeding stands, thus in the four stand 42″ tandem mill, now under construction for the Republic Steel Corp'n., at the Niles, O., plant, the motors are No. 1 stand, 500 H.P., No. 2 stand 1000 H.P. No. 3 stand, 1000 H.P., No. 4 stand, 1500 H.P.

It is of some interest to note that the speeds, and connected H.P. of the more recent cold strip mills are of about the same order as those of the hot strip mills, prior to 1932.

It is further reported that at least one of the tandem trains, now being built, will be provided with a tensioning device, intermediate the last stand of the mill, and the reel, and providing tension on the strip that may be made entirely independent of the pull of the winding reel.

## SKIN ROLLING MILLS

Perhaps the outstanding engineering development, in the cold rolling of strip for tinning, is to be found in the mills for the skin, or temper rolling, of strip in coils, after annealing. The newer mills, for this purpose, have become of considerable complexity, and are provided with electrically operated means for applying both back tension, and forward tension, to the strip during rolling and coiling.

One recent mill, of this type, is provided with two 15 KW, DC, dynamic braking generators, on the cone type feed reels, and a back tensioning device with one 125 KW generator, all on the entry side of the rolls. The rolls proper are provided with a 300 HP motor, and on the delivery side of the rolls there is a forward tensioning device with a similar 300 H.P. motor. The reel is provided with a 150 HP motor. By these means tension in the strip is controlled, both entering and leaving the rolls, by means entirely independent of the feed and winding reels, and all possibility of slippage on the reels, and consequent injury to the surface of the strip, is avoided.

A number of other mills are similarly equipped, except that the tensioning device on the entering side is omitted, the generators on the feed reels, alone, being relied upon to furnish the back tension desired. It is apparent that damage due to slipping on the feed reels is of minor importance, and in this case, has been neglected. Three recent mills, having this arrangement, are provided with two 40 KW generators on the feed reel, one 150 HP motor on the rolls, and one 125 HP motor each, on the forward tensioning device, and on the winding reel.

## COLD REDUCTION TIN PLATE CAPACITY

A brief summary of the development of cold rduction tin plate, from the standpoint of productive capacity, may not be inappropriate at the present time.

The first commercial production of strip for tinning, in other than narrow widths, 9″ and less, according to such data as is available, was in 1930, one four stand tandem mill, having rolls of 32″ face, at the Yorkville plant of the Wheeling Steel Corp'n., going into operation in that year. The capacity of this mill, initially, may be estimated at approximately 25,000 tons per year.

In the next year, 1931, a second unit, this being of the single stand, reversing Steckel type, went into operation at the plant of the Weirton Steel Co., Weirton, W. Va., and in the same year, a third unit, this of the single stand, non-reversing type, was placed in operation at the Gary Tin Mill of the American Sheet & Tin Plate Co. Thus the total capacity at the beginning of 1932 was approximately 45,000 tons.

From 1932 on the capacity was increased rapidly, as shown in the table below:

| Year | Capacity Jan. 1 | Added During Year |
|---|---|---|
| 1930 | ..... | 25,000 |
| 1931 | 25,600 | 20,000 |
| 1932 | 45,600 | 16,600 |
| 1933 | 62,200 | 114,000 |
| 1934 | 176,200 | 218,750 |
| 1935 | 394,950 | 350,750 |
| 1936 | 745,790 | 587,750 |
| 1937 | 1,333,450 | 667,000 |
| Total to Jan. 1, 1938 (est)........ | | 2,000,450 |

It will be seen, from this table, that the productive capacity has been practically doubled each succeeding year, and that, at the present time there is in operation, or approaching completion, a capacity for the production of approximately 1,333,450 tons annually of cold reduction tin plate, and it is estimated that, by Jan. 1, 1938, the annual capacity of the country will be of the order of 2,000,000 tons annually. The annual capacity for black plate for tinning, for the United States, was given, as of Jan. 1, 1936, as approximately 2,500,000 tons. The production for the first half of 1936 was 985,171 tons. From these figures it will be seen that the production of cold reduction tin plate has now become the dominant factor in the industry.

The productive capacity, as of Jan. 1, 1937, is distributed as follows:

### SUMMARY

| | | |
|---|---|---|
| Number of companies producing Cold Reduction Tin Plate...................... | | 12 |
| Number of Units and stands | Units | Stands |
| 5 stand tandem................ | 6 | 30 |
| 4 stand tandem................ | 4 | 16 |
| Single stand reversing, (driven roll) | 9 | 9 |
| Single stand reversing, (Steckel).. | 5 | 5 |
| Skin Pass mills, (4-high)......... | .. | 16 |
| Skin Pass mills, (2-high)......... | .. | 1 |
| Total................. | 24 | 77 |

## ENDLESS COLD ROLLING

At the joint meeting of the Iron & Steel Institute, (Great Britain), and the Deutsche Eisenhuttenleute, held in Dusseldorf, Germany, last September, public announcement was made of the method of rolling introduced by a Polish engineer, Sendzimir by name, which may best be described as "Endless Cold Rolling".

In the United States two methods are in use for cold rolling by successive passes in a single stand of rolls, the Steckel method, and the driven roll reversing method. Both of these methods are subject to two shortcomings, 1st., as each end of the piece is retained on the reel, and is not detached from it until the completion of the rolling, there is at the end of the operation, a length of strip at each end, which has not been subjected to any reduction, and is therefor, waste. 2d. There is a considerable loss of time, in the necessary slowing down, stopping, reversing, and re-acceleration of the mill, between successive passes.

It is self evident that, in order to reduce these losses to a minimum, the longest and heaviest possible coils should be used. In fact, it is not uncommon to weld the ends of several coils together to form a longer and heavier coil.

In order to avoid the difficulties mentioned there has been introduced, at Friedenshutte, Poland, a method of rolling in which a comparatively short piece is used at the start, and after entering into the mill, the two ends of the same piece are welded together, forming a ring, which is then passed through the mill in one direction continuously, until reduced to the desired gage, when it is sheared apart, and wound into a coil. The similarity of this method to that devised by Coryell, in this country, in 1921, (Patent 1,618,515), may be noted.

In addition to the saving in material, and in the time required, there are other concurrent advantages; for example, during the reduction, it is unnecessary to wind the strip into a tight coil, which retains the heat generated by the mechanical work, instead, the piece between passes is in the form of an open loop, with a large exposed surface from which the heat is more readily dissipated. It may, moreover, be still further cooled by means of an air blast, or fluid cooling, while free of the rolls. Another advantage is that the piece when completed may be wound loose, and in proper condition for annealing, without the necessity for rewinding. See Figure 6.

### THREE HIGH WATER MILLS

Numerous mills of the three high, water mill, type have been installed during the year, or are under construction, among which may be mentioned:

### REPUBLIC STEEL CORP'N.

### STARK SHEET MILLS, CANTON, OHIO

Two three high breakdown stands have been installed, and four two high stands modernized, with the installation of continuous pack and pair furnaces, automatic feeder and catcher tables, new pack shearing equipment, new pickling equipment, and additional cold rolling stands.

### REPUBLIC STEEL CORP'N.

### TIN MILLS, WARREN, OHIO

Two three high breakdown mills have been ordered together with continuous pair and pack furnaces, automatic feeder and catcher tables, and auxiliary equipment. Two existing, two high finishing mills are being likewise equipped with continuous pack furnaces, feeder and catcher tables, etc.

### WHEELING STEEL CORP'N.

### BEECH BOTTOM WORKS,

### BEECH BOTTOM, W. VA.

The Wheeling Steel Corp'n., has recently ordered two completely mechanized three high mills for the production of breakdowns for the sheet finishing mills.

### CONTINENTAL STEEL CORP'N

This company has just placed an order for two three high mills, for the production of breakdowns for sheet finishing mills, complete with continuous pair furnaces, automatic feeder and catcher tables, etc., one for the Canton, Ohio, and one for the Indianapolis, Ind. plant.

### STECKEL HOT MILL

One reversing hot strip mill, of the Steckel type, has been placed in operation by the Dominion Foundries and Steel, Ltd., Hamilton, Ont.

The mill was formerly a two high reversing universal plate mill, built in 1920, and having rolls 27″ x 72″, and capable of rolling universal plates to 40″ wide, and with the vertical rolls removed, sheared plates to 60″ wide, in gages from $\frac{3}{16}$″ upward.

To the existing mill there has been added two coil reheating, or rather heat conserving, furnaces, with the necessary pinch rolls, deflectors, and coilers within the furnaces. The furnaces are of the type usual in Hot mills of the Steckel type, elevated above the tables, front and back of the rolls, and at a distance of about 18 feet, from the rolls. There has also been provided a coiler for the finished strip.

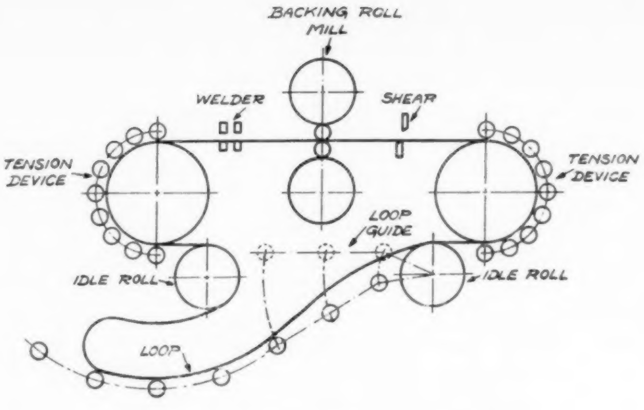


Figure 6—"Sendzimir" System of Rolling.

In the revamped mill, slab ingots, 14″ thick, by 48″ long, and in various widths up to 36″, are reduced in a single operation to strip of 12 gage and heavier. The rated capacity is given as 10,000 to 15,000 tons per month, of plate and strip.

The operation of the mill is similar to that of the two other hot mills, of the Steckel type, already in operation. That is, the slab ingot is reduced to a plate of approximately $\frac{5}{8}$″ thickness, by alternate forward and back passes. On the next succeeding pass the piece is deflected upward into one of the two heating chambers, and coiled within the chamber. Succeeding passes are then made in the same manner, the strip passing out of the one chamber, through the rolls, and into the chamber on the opposite side of the rolls, until reduced to the desired gage.

### BEARINGS

Bearings of the sleeve type, with oil film lubrication, came into greatly extended use in 1936. Five complete installations, including both hot strip mills, and cold strip mills, have now been installed, or are under construction, in which the backing rolls are equipped throughout with this type of bearings. In addition, seven cold strip mills are similarly equipped, besides numerous smaller installations, and replacements. It would seem, that the objective of many years study and experiment, a bearing having a coefficient of friction comparable with that of the roller bearing, combined with contact area of the plain bearing, had at last been achieved.

### AUXILIARY APPARATUS

Among the types of auxiliary apparatus, of which some mention should be made are:

*Pressure Meters* for indicating, and recording, roll neck pressures, many of which are now in use.

*Electrolytic Cleaning Lines*, particularly for the preparation of cold reduction tin plate, are in general use at practically all plants making this class of material.

## ECONOMIC AND SOCIAL FACTORS

The preceding portions of this paper have been devoted to the engineering, or technical aspects of flat steel rolling. There is another aspect to the introduction of improved and more efficient equipment in general, and of the strip method of flat steel rolling, in particular, that is of outstanding importance at the present time, and the failure to justly evaluate which may constitute a serious threat to the continuance of the developments which have marked the past ten years.

I refer to the economic, or social view point, and to the effect upon employment. The obtaining of a true picture of the results of the introduction of improved equipment is particularly important on account of the ignorance of the facts, and mis-understanding of the results, pertaining to these developments, in governmental circles, as well as among the self-labeled champions of the laboring man.

I ask your indulgence for a brief, and somewhat tentative consideration of some of these facts, and for some of the conclusions to be drawn from them.

Two typical examples of this mis-understanding, and mis-interpretation, of facts and results, have recently been brought into the limelight of public attention.

## HOUSE RESOLUTION NO. 49

Early last year, the following, House Resolution No. 49, was presented by representatives Palmisano, Democrat, Maryland.

Quote: "Directing the Secretary of Labor to compile a list of labor-saving devices, mechanical or otherwise, put into operation in the United States, after Dec. 31, 1912, which are still in use, to estimate the number of persons in the United States, now unemployed by reason of the use of each kind, or type, of such device, and to estimate the number of persons who would be employed in each of the various divisions of industry, commerce, or agriculture, but are not so employed, by reason of such devices". Unquote.

This, it may be noted in passing, it not a statement of alleged facts, but the assumption that unemployment is due to such labor-saving devices, is apparent.

## COMMITTEE FOR INDUSTRIAL ORGANIZATION

According to the newspapers, the following statement was made last summer, at a mass meeting of the Steel Workers Organizing Committee, of the C. I. O.

Quote: "2500 men will be thrown out of work with the completion of the largest strip mill in the world, at Sparrows Point, Md., by the Bethlehem Steel Co." Unquote.

The speaker further said:

Quote: "If we had a strong steel organization before construction started, and we could have legislation put into effect, taxes would have been levied, and the money used, for the benefit of the men done away with." Unquote.

This is a fair sample of the mis-statements and loose talk that is now prevalent. The most charitable interpretation of such statements is that the makers of them are ignorant of the facts, and that they are not made with the intention to mislead.

## THE STEEL INDUSTRY

As far as concerns the steel industry, the introduction of improved, and more efficient equipment, and machinery, has up to the present time, been manifestly unsuccessful in reducing either the total number of employees, or the pay-roll. Neither has it been successful in reducing the average labor cost, or the number of employees, per ton of finished rolled steel produced.

While the overall cost of production may be reduced temporarily, and may be reduced more or less permanently, in certain departments, and for certain products, the long range overall effect has been quite the contrary.

These conditions have ruled in the past,and we have no reason to believe that they are not binding now, nor that they will not be binding in the future.

## U. S. STEEL CORPORATION

It is, of course, difficult to obtain complete figures covering production, sales and earnings, pay-rolls, number of employees, etc., for the steel industry as a whole, except for quite recent years.

We may, however, take for our purpose the figures provided by the annual reports of the United States Steel Corporation, as furnishing a representative cross section of the industry.

We choose these figures because:

1—They are readily available for study and analysis.
2—They cover an extended period, from 1902 to date.
3—They represent a large tonnage, ranging from approximately one half of the entire production of the country, in 1902, to one third, in 1935.
4—The range of products covered by them is large, and fairly representative of the industry as a whole.
5—The reports are quite complete, more so than is usual in similar published reports, and are prepared without obvious bias.
6—The expenditures by the Corporation, for improved equipment, have at the least, been on a par with the average for all companies.

## ANALYSIS OF REPORTS

For our present purposes, it will be sufficient to compare the figures for two periods, one from 1902 to 1906, and the other from 1931 to 1935, both inclusive. It was between these two periods that the greatest advances in the technology of the iron and steel industry have taken place.

## PRODUCTION

Comparing the production of finished rolled steel products, we find that the average annual production of the United States Steel Corp'n., for the first five year period was 8,265,667 tons, while the average for the last five year period, which included the entire depression, was somewhat less, 6,056,668 tons.

## EMPLOYEES AND PAY-ROLLS

In spite of the reduced average production of the last period, we find that the number of employees has increased from an average of 172,041 to an average of 183,797, for the two periods. The average annual pay roll has increased from $124,316,500 to $205,202,813. The average pay-roll per ton of finished rolled steel produced has increased from $15.04 for the first period, to $33.88, for the last period. The number of employees per 1000 tons of annual production has increased from 20.8 for 1902-6, to 30.3 for 1931-5.

### SALES AND EARNINGS

The gross sales and earnings of the corporation, for the first period averaged $513,366,790, and for the last period $592,410,113. The percentage of wages and salaries, (pay-roll) to gross sales and earnings has increased from 24.2% to 34.7%. During the period from 1931-1935, the ratio of pay-roll to sales to outsiders, (inter-company sales and transportation, and other earnings being excluded), amounted to 51.3%.

### EARNINGS AND HOURS

The average earnings of employees, per hour, has increased from less than 30 cents in 1902-6, to over 70 cents in 1931-5, and the average yearly earnings from $724 to $1116. The number of hours worked per week has decreased from about 70 to about 40, or less, being 34 in 1935, and about 40 in 1936.

### TAXATION

The average annual taxes paid during the 1902-6 period was $3,283,930, or about $ .40 per ton of finished rolled steel produced.

In the 1931-5 period the taxes averaged $34,488,684 annually, or about $5.70 per ton. This is about 14 times the former figure.

### SUMMARY

It will readily be seen, from the fore-going figures, that, as far as the U. S. Steel Corp'n., is concerned, and presumably for the steel industry as a whole, in spite of the outlay for repairs and maintenance, extraordinary replacements, and capital expenditure, intended to keep the plants at the highest state of efficiency, and amounting in the aggregate to over $4,000,000,000, the net results have been an increase in the pay-rolls, and the number of employees, both as a whole and per ton of finished material produced.

### DETERMINING FACTORS

These apparently anomalous results may be explained by a consideration of the following factors:

1—The demand for, and production of, the commodity produced by an improved method has been increased, with a resultant increase in production, and in employment, all the way back from the finished product to the raw materials.

2—The higher standard of quality demanded of the finished product, and made possible by the improved machinery or process, results generally in increased employment, and pay-roll both in the prior operation of steel making and for the after operations of finishing, inspection, and shipping, as compared with the superceded process.

3—Service requirements, for example the prompt delivery necessitated by the present hand-to-mouth buying, prevents the accumulation of substantial rollings, and makes necessary additional roll changes, for small tonnages, with resulting decrease in hourly production, and increase in labor expenditures. The alternative procedure, of carrying in stock a wide cariety of shapes and sizes, at the mill, in its turn, entails additional handling, and labor.

4—The general advance in hourly labor rates, and reduction in the number of hours in the work week, which has been particularly marked in the steel industry, tends in the long run, to overtake any reduction in the number of employes, and to cancel out any initial labor saving, made by improved equipment, or methods.

### EXPANSION IN DEMAND

In further explanation, it should be remarked that the steel industry is not a static industry, that is to say, one which has reached a saturation point, and is incapable of absorbing increased production. On the contrary it is an essentially dynamic industry, and whenever a commodity produced by it becomes more desirable to the customer, either by reason of a decrease in the cost of the commodity itself, or because the commodity produced is more suitable for the purpose for which purchased, and will either produce a superior product, or at a lower cost, then expansion in the demand will naturally follow. Furthermore, the introduction of a new method of production of a commodity may open up an entirely new field, hitherto inaccessible either on account of the cost of the commodity, or on account of the physical qualities then obtainable. Today many such fields are in process of being opened up.

Any such increase in demand results in an increased production, all the way back, through the integrated process, to the original natural sources, in the steel industry, for example, the iron ore, limestone, coal, etc. Furthermore, the directly or remotely connected facilities, such as power, light, fuel for heating, labor and materials in maintenance and repairs, and operating materials, such as oil and grease, brasses and bearings, all share in the increased activities.

Thus, the increased production of a single ton of one of the more highly finished, rolled steel products, would result in an increased demand for labor which would amount to approximately 50 men for one hour.

A concrete example will perhaps, serve to make this clearer. Take, for example, a fairly highly finished product, for example sheets, requiring a total of 50 man-hours labor in its production, and assume a saving of five man-hours per ton as being made possible by improvements in some particular operation which formerly required 15 man-hours per ton. This, it will be granted, is a very considerable saving, and one which would warrant a substantial capital expenditure to accomplish it.

Again assuming a production of 100,000 tons of the particular commodity for the plant before the introduction of the improved method. We may then readily calculate the required increase in production to return the pay-roll to its former figure, assuming the level of wages to remain constant.

100,000 tons x 50 man-hours per ton equals 5,000,000 man-hrs. Divide this by the new figure of 45 man-hrs. per ton, we arrive at 111,111 tons, or an increase of about 11%.

A slight improvement in the quality, or a slight decrease in the price of the commodity, would readily accomplish such an increase in production and, as far as concerns the total number of employees, and total pay rolls, the 33⅓% saving in labor, in the one department, would be taken up completely elsewhere.

In fact, if the introduction of new and improved machinery and equipment, or methods of production, does not actually result in an increasing number of employees, and of increased pay-roll, the sales methods of the company may well be looked at with suspicion.

## DISPLACEMENT OF LABOR

Generally speaking, the introduction of improved equipment, so-called labor saving, results in a reduction in employment largely in the unskilled, and therefor lowest paid, groups, and the average earnings per man-day are increased.

In the case of the displacement of the conventional sheet mill by the Broad Strip Mill, there has, of course, been a reduction in the number of the highly skilled, and highly paid, rollers and heaters, but this is offset by the multiplication of only slightly less highly paid occupations.

Furthermore the displacement has been gradual, extending over a period of approximately ten years, and is, in fact, not yet complete, and has meant not so much the loss of employment of the younger men already employed, but as an offset to the retirement of the older employees, and the lack of trained younger men to take their place. Even before the introduction of the Broad Strip Mill the lack of younger men, willing and able to learn, and perform, the manual labor of sheet rolling, was a real problem.

## AUTOMOTIVE INDUSTRY

The results of the improvement in quality, widened range of product, and reduction in price, due to improved methods of production, in the steel and allied industries, is well exemplified in the motor car of today, and is probably familiar to all.

It will, I believe, be readily granted that the record production of more than 4,500,000 passenger cars and trucks, in the United States, during 1936, would have been impossible unless a great deal had been offered, both in appearance, and in quality, at a low price.

It is a far cry from the Ford Model T, with its pedal operated transmission, flat fenders, and square body, instrumentless instrument board, and any color desired as long as it was black, to the Ford V8, of today, with stream lined body and fenders, and every conceivable gadget, including a radio, and in general appearance superior to the most expensive cars of former days.

Would the car of today have been possible without the technical developments of the past ten years, of which the Broad Strip Mill is only one? I think that the answer is, NO.

The statement has been made that, if it were not for modern mechanical equipment an automobile now selling for $600 would cost $3500. Had the same quality of auto-body sheet that was to be obtained in 1926, only, been available, and at a price that would cover todays cost of production, I have been reliably informed, that the cost of parts made from such sheets would be more than double what it is today.

Furthermore, with the sheets obtainable in 1926, it would have been quite impossible to produce cars having the style appeal of those today, extra deep drawn one piece fenders, with deep valances, one piece steel tops, stream lined hoods and bodies, etc. Sheets, in 1926, were unobtainable either in the necessary widths or with the required physical properties, to form such parts.

## JUSTIFICATION FOR EXPENDITURES

It is apparent that justification for the expenditures required for new and improved equipment, and methods, must be sought elsewhere than in any saving in total pay-roll, or even in a saving in pay-roll per ton of product, other than a temporary one.

What then is the justification for the tremendous expenditures that have been made, and are still being made, for example: the expenditure of some $375,000,000, that has gone into the Broad Strip Mills during the past ten years- The justification, at least in my opinion is:

1—That the market for the product is broadened, either on account of improvement in quality, reduction in prices, or a combination of the two, and that an increased production may reasonably be counted on.

2—That the company which does not have the improved equipment may expect to experience a shrinkage in its market, and a loss of business to companies having the improved equipment, on account of inability to compete on the score of price, or of quality.

3—That the introduction of the improved equipment, or method, raises the general standard of the commodity. More exacting standards of quality are demanded without extra charge, and these standards are met, only with difficulty, and at an increased cost, by the producers using only the older methods and equipment.

4—That the general trend of rising wages and reduction in hours, increases the labor cost in a lesser proportion for the companies having the improved equipment, than for those companies not having it.

5—That an actual saving may be expected in some items of production cost, such as percentage yield from the raw materials, reduction in power, fuel, rolls, etc., all of which go to decrease the cost of conversion.

### EFFECT OF INCREASING WAGES

It may be opportune, at this point, to consider the long term effect of the rising spiral of wages, in its relation to prices and volume of business.

The money required for increased wages may be provided from one or more of the following sources:

1—By the government, in the shape of a subsidy on production or on non-production, as is the case with agriculture, such subsidy being considered as a legitimate governmental function.

2—By the investors, in the shape of a reduction in the return on capital, and affecting first, the return on the common stock, second the return on the preferred stock, and finally the return on bonded debt.

3—By the management, in the shape of improved efficiency, that is to say, lower overall unit costs, and increased spread between receipts and expenditures due to improved methods, or equipment, and to increased rate of operation.

4—By the consumer, in the shape of increased prices unaccompanied by improvement in quality, whereby the cost of the final product is raised.

It may be taken as axiomatic that the only economically justifiable method of providing the money required for increases in wages is from the increased earnings made possible by improved equipment and methods, and increased volume of business. It is moreover the only permanent source from which high wages may be maintained or improved.

In order to accomplish lower overall costs there must necessarily be constant replacement of existing equipment by newer equipment, capable of more efficient operation, irrespective of the fact that the superseded equipment may still be physically good for a longer life. Such replacements require the accumulation of substantial reserves for the purpose which may be obtained only from earnings, or by incurring additional obligations in the shape of interest bearing debt.

### TREND OF PRICES

In spite of the factors which have been tending to increase the cost of steel products, and particularly the rising wage level, increased taxation, and other governmental demands, and the increased carrying charges required by the investment in new equipment; during the period from 1918 to 1933, the general trend of prices in those products in which the technical advances have been most marked, for example, sheets, have been downward for equivalent products. During this same period the quality of the product has been vastly improved. so that the ultimate cost of the consumers goods produced have been lowered in still greater proportion.

Beginning with 1933, (operation of N.R.A.) we may note the beginning of a trend of opposite character, the upward revision of prices.

During the first period wage advances were, generally speaking, absorbed by the steel producers, and provided from earnings, or lacking this, at the expense of the return on invested capital. During the second period, and particularly at the present time, first quarter of 1937, these additional costs are being passed on to the customer.

While as yet prices have not been advanced to a point where they will have an appreciable effect on the volume of consumption, additional wage increases may have that effect, thus acting as an effective brake on recovery, and will defeat their own object, of larger earnings for the employees.

### CONCLUSION

In closing this paper, it is perhaps, not an unfair question to ask:

> "What then has been the net result of the expenditures that have been made so liberally, in the past, for the introduction of improved machinery, equipment, and methods–"

We may give at least, a tentative answer:

1—The employees have had their yearly wages increased more than one half, and the number of hours worked reduced by nearly one half. Their numbers have been increased rather than diminished. Their working conditions have been greatly improved, and most of the hard work and drudgery eliminated. Their safety at work has been made greater than that of the average man on the public highways.

2—The customer has been able to secure a much superior product, and at a lower ultimate cost, and to produce a final product that was formerly either impossible of production at all, or only at a prohibitive cost.

3—The investors have received no advantage, except on a few exceptional occasions in the past, and during recent years, have had their income reduced, or wiped out.

In short, substantially all the benefits of the improved technique, secured at a cost of several thousands of millions of dollars, have gone to the wage earners, and to the customers, and thus eventually to the public at large.

# *Nickel Chilled Rolls*

## AND SOME OF THEIR APPLICATIONS

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▲ ABOUT ten years ago an announcement appeared that there had been developed a nickel-chromium white cast iron, which was harder, tougher and stronger than plain white cast iron. The sponsors* announced that when nickel and chromium were added to a chilled white iron base mixture in such proportions as to maintain a white structure, the chilled surface would show a Brinell hardness of 150 to 250 numbers higher than that of corresponding plain chilled cast iron.

At about the beginning of 4-high mill developments, demands were increasing for rolls stronger and also harder than plain chilled iron rolls to resist tail marking and orange-peel effects, especially for hot rolling, as hardened steel rolls did not resist fire cracking and maintain their hardness, even with a voluminous supply of water running on them. Hardened steel rolls for cold rolling were relatively expensive so that the industry was demanding a roll cheaper than steel and better than ordinary chilled iron for this application. With the foregoing in view, many roll shops turned to alloying with nickel and chromium, as well as other elements such as molybdenum and manganese, and developed particular compositions which were compatible with shop conditions and requirements in each application and consequently identified these specially processed rolls by trade names.

The hardest chilled iron rolls will have a composition within the limits of the ranges shown in Table I.

Chilled white cast iron, alloyed or unalloyed, is essentially about 50% matrix and 50% carbide. The carbide in either case has approximately the same hardness (800 BHN), but in unalloyed iron the matrix is soft pearlite having a hardness of 200-220 BHN, and in fully alloyed nickel iron the matrix is martensite, having the hardness of the hardest tool steel. Nickel combines with the matrix to form martensite, but it also has the tendency to prevent the formation of carbide, thereby reducing the chill depth. With the addition of nickel to a white cast iron base mixture, it is necessary, therefore, to counteract the latter effect by lowering the silicon or by the addition of carbide-forming elements, such as chromium, sulphur, or molybdenum or vanadium. Since silicon is similar, but not as mild in its effect on the chill depth as nickel, silicon together with chromium is often reduced to the lower limits as listed in Table I. It is possible ,however, with still lower silicon and somewhat lower total carbon than is common in roll compositions to produce a nickel chill without any carbide-forming elements, but this is not feasible where strength requirements and present methods of roll manufacture are considered.

Inasmuch as it is not advisable to reduce silicon too low, the hardest nickel alloyed chilled rolls contain chromium or sulphur, or molybdenum, or all three. In these rolls, chromium is rarely under 0.50% and may exceed 2.0%. The chilling power of chromium is counteracted by carbon, nickel and silicon, and if high chromium, not in excess of about 1.50%, is preferred,

TABLE I

COMPOSITION RANGES FOR HARDEST ALLOY CHILLED ROLLS

| | |
|---|---|
| Total Carbon | 2.75–3.75% |
| Silicon | 0.25–1.25% |
| Manganese** | 0.15–1.50% |
| Phosphorous | 0.03–0.50% |
| Sulphur | 0.03–0.15% |
| Nickel | 4.00–6.00% |
| Chromium | 0.50–2.25% |
| Molybdenum | Up to 1.0% |

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*Messrs. Merica, Vanick and Wickenden of The International Nickel Co., Inc.

**Manganese is usually under 0 40% or over 1.0%.

## TABLE II

Subdivision of Table I, Listing the Approximate Composition Ranges of the Different Types of the Hardest Alloy Chilled Rolls

| No. | Type | T.C. | Si | Mn | P | S | Ni | Cr | Mo |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Low Total Carbon Definite Chill | 2.75–3.25 | 0.25–0.50 | 0.15–0.40 | 0.20–0.50 | 0.05–0.15 | 5.0–6.0 | 0.50–1.00 | Up to 1.0 |
| 2 | High Total Carbon Definite Chill | 3.25–3.60 | 0.25–0.75 | 0.15–0.40 | 0.20–0.50 | 0.05–0.15 | 4.5–5.5 | 0.75–1.50 | Up to 1.0 |
| 3 | Low Total Carbon Indefinite Chill | 2.75–3.25 | 1.00–1.25 | 1.25–1.50 | 0.03–0.20 | 0.03–0.05 | 4.0–5.0 | 1.75–2.25 | .... |
| 4 | High Total Carbon Indefinite Chill | 3.25–3.75 | 0.80–1.10 | 1.25–1.50 | 0.03–0.20 | 0.03–0.05 | 4.0 5.0 | 1.75–2.25 | .... |

the depth of clear chill can be controlled by silicon up to 0.80–0.90%. When a clear chill type roll is preferred, it is advisable to keep chromium under 1.50%. When 4.50% to 5.0% nickel and one-fourth to one-third as much chromium as nickel are added to a plain chilled iron roll composition, having a normal silicon content, the depth of clear chill of the alloyed roll and unalloyed roll will be about the same. There has been considerable interest in rolls having not a definite chill, but a hardened structure from surface to center. This type of roll, containing chromium in excess of 1.50% and occasionally exceeding 2.00–2.25%, has a surface hardness as great as the definite chill type and correspondingly hard unmachinable necks.

In Table I, listing the limits of the hardest alloy rolls, it is noted that manganese is usually under 0.40% or over 1.0%. For the clear chill type, it is essential to keep the manganese low in order to control the depth of clear chill. Manganese counteracts the chilling tendency of sulphur and when they occur in the ratio of 5 to 6 manganese to 1 sulphur, the effect of both is destroyed. When manganese is in excess of the amount necessary to satisfy the sulphur, it has the tendency to scatter the chill. Most generally sulphur in the clear chill type roll is added in excess of the amount necessary to satisfy the manganese for the purpose of obtaining the desired depth of chill. In the high-chromium indefinite chill type roll, low sulphur and manganese over 1.0% and up to 1.50% have been successful in eliminating tail marking and orange-peel effect, as well as increasing the depth of hardened zone.

Table I, which shows the general composition range for all types of hardest alloy chilled rolls, is subdivided into four general types and the approximate composition ranges of each type are listed in Table II. It should be noted that Nos. 1 and 2 are the clear chill types and contain low manganese and low to medium chromium. In the second type, 1.50% chromium is fairly high for a clear chill type as it rarely exceeds 1.30–1.40%. Nos. 3 and 4 are the indefinite chill type. They contain high chromium and high manganese and have strong but unmachinable necks.

Maximum hardness can be obtained with nickel as low as 4.0%, provided the chromium and total carbon, as well as manganese and molybdenum, if desired, are on the high side. Other than forming carbides, chromium, manganese and molybdenum aid nickel in forming a martensitic matrix. An increase in total carbon increases the amount of carbide constituent and thereby decreases the amount of matrix; consequently less nickel is necessary to form the martensitic matrix, since nickel presumably alloys with the matrix, but very little, if any, with the carbides.

Means for obtaining maximum hardness have been discussed, but with more moderate alloying, rolls having hardnesses less than the fully alloyed metal rolls can be secured. A white chilled iron increases progressively in hardness with additions of nickel and with the aid of chill-forming elements to maintain chill depth, such as chromium or molybdenum, or sulphur, or all three elements. Any hardness between that of plain chilled iron rolls, which are 60-70 Scleroscope, and that of fully alloyed rolls, which are 85-92 Scleroscope, can be obtained with alloy additions less than those used for the fully alloyed type of composition.

The effect of additions of nickel and chromium upon the structure of chilled or white cast iron is twofold as shown by the following micrographs made of the chill portion of roll spalls:

(a) Nickel and chromium progressively refine the carbide network (white) as shown in Figs. 1A, 1C and 1E.

(b) Nickel and chromium alter the ground mass progressively from pearlite through sorbite and troostite to martensite (the dark constituent in each case) as shown in Figs. 1B, 1D and 1F.

It is this combination of cementite (white) and martensite (dark) in Fig. 1F which contributes to the higher hardness, strength, toughness, and wear resistance of the fully alloyed metal over plain chilled or white iron.

Table III shows the properties of low and high carbon chilled iron with and without nickel-chromium additions:

## TABLE III
### Typical Results of Tests of Chilled Plain and Fully Alloyed Irons

| | Plain Iron | | Fully Alloyed Nickel | |
|---|---|---|---|---|
| | High Carbon | Low Carbon | High Carbon | Low Carbon |
| Brinell Hardness of Chilled Surface | 500 | 400 | 650 to 700 | 575 |
| Tensile Strength in Chilled Section (PSI) | 35 to 40,000<br>(1) | 48 to 53,000<br>(2) | 55 to 60,000<br>(2) | 70 to 80,000<br>(2) |
| Tensile Strength in Grey Core (PSI) | 16 to 25,000 | 22 to 39,000 | 30 to 35,000 | 40 to 50,000 |
| Total Carbon | 3.50 | 2.75 | 3.50 | 2.75 |
| Silicon | 0.75 | 0.75 | 0.75 | 0.75 |
| Nickel | .... | .... | 4.50 | 4.50 |
| Chromium | .... | .... | 1.50 | 1.50 |

(1) Calculated from transverse tests.
(2) Test pieces ground from chilled blocks to 0.800″ diameter A.S.T.M. Standard.

The effect of increasing additions of nickel and chromium is shown in Fig. 2:

Fig. 1

Fig. 1A—Structure of Plain Chilled Iron Spall x 100.
Fig. 1B—Pearlitic Matrix of Plain Chilled Iron Spall x 500.
Fig. 1C—Structure of moderately hardened Spall (2.68 Ni .39 Cr .33 Mo) x 100.
Fig. 1D—Sorbitic Matrix of Fig. 1C x 500.
Fig. 1E—Structure of fully hardened Spall x 100.
Fig. 1F—Martensitic Matrix of Fig. 1E x 1000.

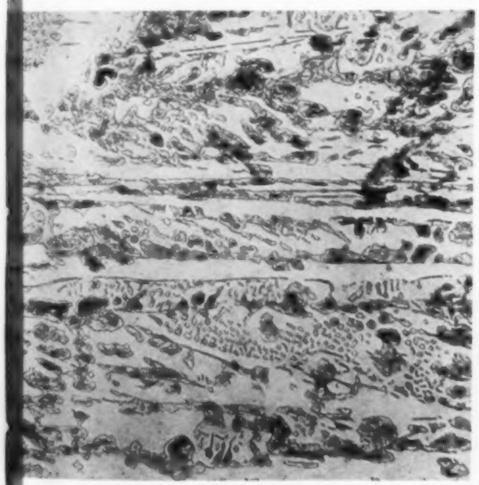
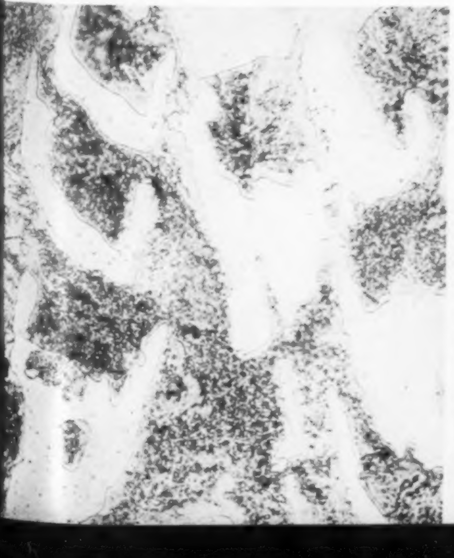


Fig. 1A

Fig. 1D



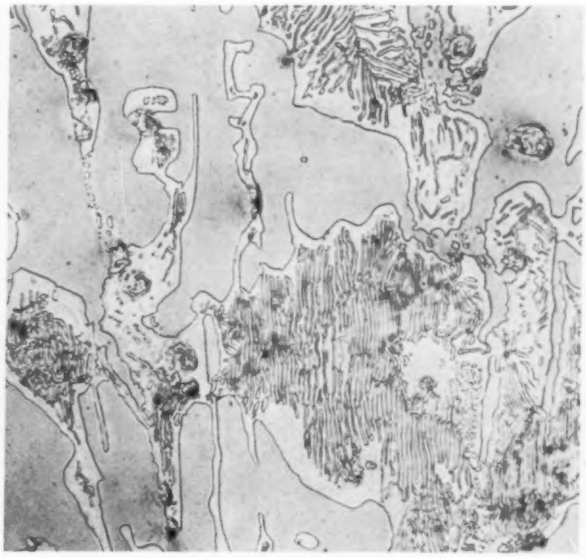
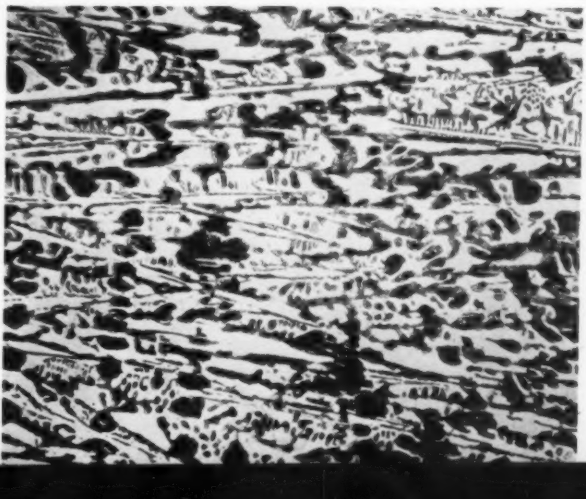


Fig. 1B

Fig. 1E



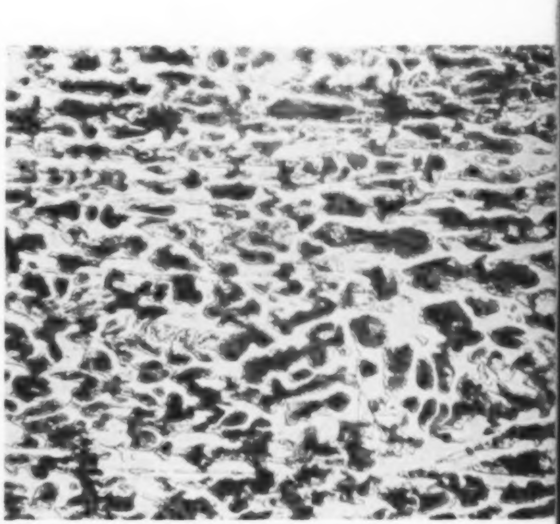
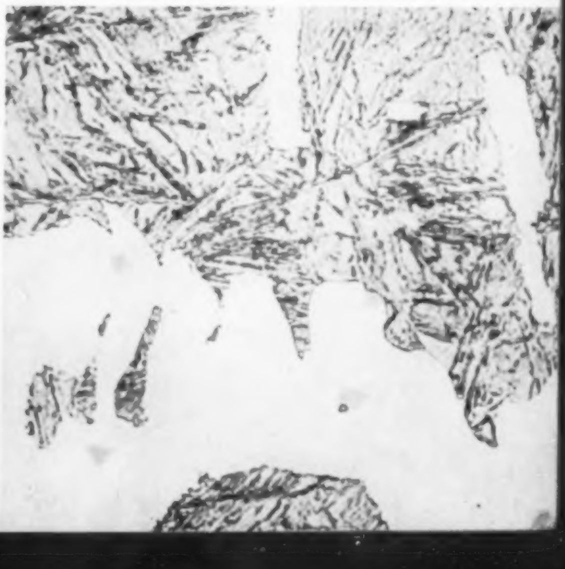


Fig. 1C

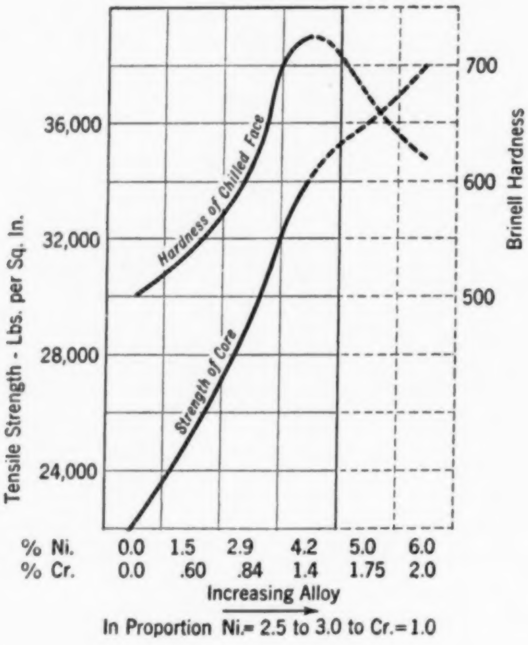
Fig. 1F



**Total Carbon Approx. 3.5%**

**Silicon .95 to 1.0%**

FIG. 2



Not only is the chill hardness increased as the total alloy content is increased, but the strength of the grey core is increased considerably. The grey core of the fully alloyed iron (right hand column of Fig. 2) is about 40% stronger than the core of the plain chilled iron of the same base composition. In Fig. 3 the effect of similar alloy additions to a lower carbon iron is shown. The chill hardness is somewhat lower and the strength of the grey core higher than in similar compositions of higher carbon content.

The chill of a plain chilled iron roll, usually analyzing 3.00–3.10% total carbon, has approximately 45% cementite having a Brinell hardness of 750-800 and 55% pearlite having a Brinell hardness of 200-220. Therefore, the resultant average hardness of the two constituents is approximately 465 BHN or 65 Scleroscope. The wide difference in hardness between the two constituents seems to be the reason for the orange-peel effect and tail marking. On the other hand, in the chilled portion of a fully alloyed roll the hardness of the martensite approaches that of the cementite with the resultant hardness of the two approaching 700 BHN or approximately 92 Scleroscope. It has been reported that small experimental rolls have been made to exceed 100 Scleroscope in hardness, but it is not always advisable to strive for maximum hardness, as other requirements in each application should be considered.

Fig. 4, a photomicrograph of a scratch hardness test on a plain chilled iron roll spall shows a wide scratch through the soft pearlite and a narrow scratch through the much harder cementite. Fig. 5, a photomicrograph of a fully alloyed high-manganese roll spall, similar to Type No. 4 in Table II, shows the uniform thickness of scratch throughout both martensite and cementite indicating practically uniform and equal hardness of both. This insures equal rate of wear of both constituents, and, therefore, longer life between dressings, and, most important, freedom from tail marking and orange-peel effect on sheets.

The various types of rolls and their approximate composition ranges, referred to in the following specific applications, are listed in Table IV.

### COLD ROLLING SHEET AND STRIP

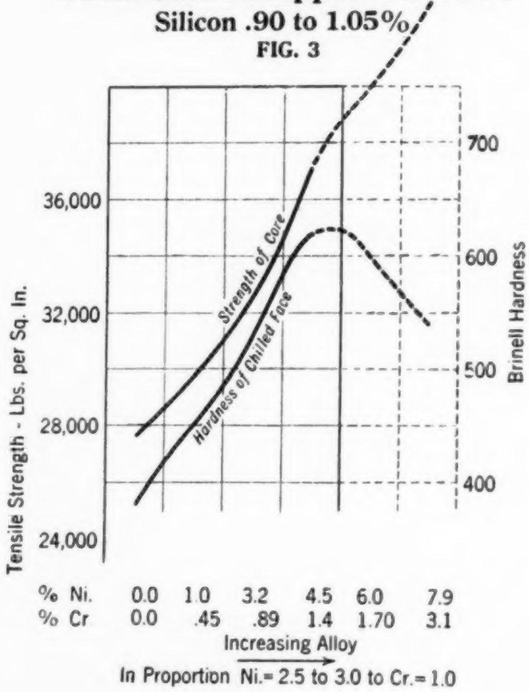
The more important application for hard nickel-chromium rolls, which have various trade names, is for cold rolling ferrous and non-ferrous sheets and strips, where good finish, greater strength and wear resistance are desired. For this application the fully hardened alloyed composition similar to Types Nos. 1 and 2 in Table IV, and having Scleroscope hardnesses in excess of 85 Scleroscope are selected. It has been reported that rolls as high as 92-95 Shore have been satisfactory. However, when considering this high hardness it is advisable to take into account other requirements of each application, such as shock and spall resistance. Incidentally, rolls of this type work harden in service and may increase as much as five points in Scleroscope hardness. In a continuous mill it is common practice to equip all but the last stand with the alloy rolls, and when a finer finish is not necessary they are included in the last stand.

The fully hardened alloy rolls in this paper are divided into two types: (1) definite chill type and (2) indefinite

**Total Carbon Approx. 2.80%**

**Silicon .90 to 1.05%**

FIG. 3



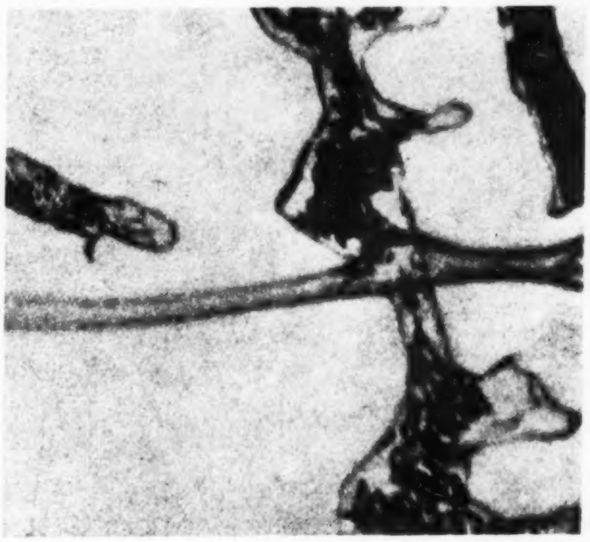


Figure 4—Photomicrograph of scratch hardness test on a plain chilled iron roll spall x 3000.

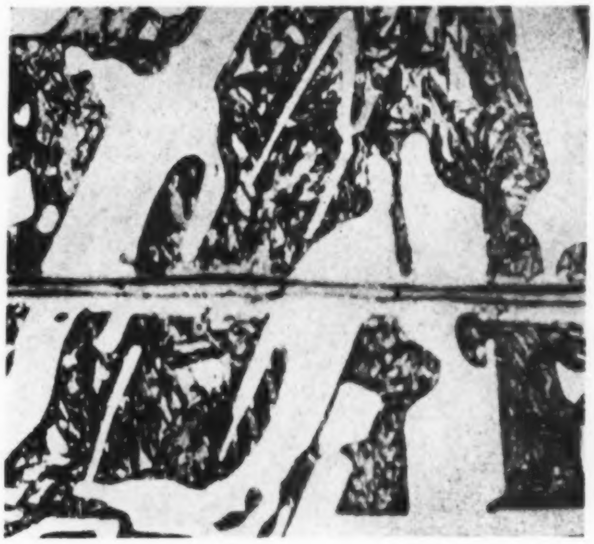


Figure 5—Photomicrograph of scratch hardness test on fully alloyed roll spall x 2000 (similar to Type No. 4 in Table II).

chill type. Both types contain approximately the same amount of nickel (4.0–6.0%), although other elements such as silicon, manganese and chromium, are regulated in such a manner as to produce rolls (1) of Type No. 1 in Table IV having definite chill, (2) of Type No. 2 in Table IV having indefinite chill, but a densified structure having a hardness as great as the definite chill type. Both types usually possess distinct depths of clear chill which might, however, require microscopic inspection in the case of the indefinite chill type to locate the inception of graphite nodules or "mottle." Both types have their merits. It cannot be said that one type is superior to the other unless its particular application is taken into consideration, as both types have been about equally successful in cold finishing ferrous strip. As each type has its advantages and disadvantages, selection of the one most suited for a particular condition should be made after both have been given a fair trial.

The experience of Messrs. J. J. Habershon & Sons, Ltd., Rotherham, England, reported by the Mond Nickel Co., Ltd., in a bulletin*, has been that nickel-

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*Mond Nickel Co., Ltd., Bulletin entitled "Ni-Hard Rolls in Strip Mill Service."

TABLE IV

VARIOUS TYPES OF ROLLS AND THEIR APPROXIMATE COMPOSITION RANGES REFERRED TO IN SPECIFIC APPLICATIONS

| No. | Type | T.C. | Si | Mn | P | S | Ni | Cr | Mo |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Definite Chill....... | 2.75–<br>3.60 | 0.25–<br>0.75 | 0.15–<br>0.40 | 0.20–<br>0.50 | 0.05–<br>0.15 | 4.50–<br>6.00 | 0.50–<br>1.50 | Up to<br>1.00 |
| 2 | Indefinite Chill...... | 2.75–<br>3.75 | 0.80–<br>1.25 | 1.25–<br>1.50 | 0.03–<br>0.20 | 0.03–<br>0.05 | 4.00–<br>5.00 | 1.75–<br>2.25 | .... |
| 3 | Definite Chill....... | 2.75–<br>3.60 | 0.25–<br>0.75 | 0.15–<br>0.40 | 0.20–<br>0.50 | 0.05–<br>0.15 | 3.50–<br>4.50 | 0.35–<br>1.25 | Up to<br>0.50 |
| 4 | Definite Chill....... | 2.75–<br>3.50 | 0.25–<br>0.75 | 0.15–<br>0.40 | 0.20–<br>0.50 | 0.05–<br>0.15 | 1.50–<br>3.50 | 0.20–<br>0.75 | Up to<br>0.5 |
| 5 | Grain.............. | 2.50–<br>3.00 | 0.75–<br>1.50 | 0.25–<br>0.75 | 0.05–<br>0.20 | 0.05–<br>0.10 | 2.00–<br>3.00 | 0.75–<br>1.75 | Up to<br>0.50 |
| 6 | Grain.............. | 2.75–<br>3.40 | 0.75–<br>1.25 | 0.25–<br>0.75 | 0.05–<br>0.20 | 0.05–<br>0.10 | 0.75–<br>2.00 | 0.75–<br>1.50 | Up to<br>0.50 |

chromium rolls, having an initial hardness of 80 Shore, have a wearing quality at least as good as that of a hardened steel roll of 90 Shore or over. They report that the necks of the alloy rolls stand up very much more satisfactorily than do those of the hardened steel rolls, as the latter are often found to be badly scored and grooved after the rolls have been in service for some time, whereas with the hard nickel-chromium rolls this trouble is absent. They also report that in a certain 2-high cold mill, plain chilled iron rolls were originally used, mainly for economic reasons, but they were replaced by alloy rolls whose wearing quality has proved much better than that of plain iron and a surface comparable to that of hardened steel. As an example, Habershon reported that a set of nickel-chromium rolls, which had been in service over a thousand shifts rolling all classes of steel strip, had required only twelve dressings, removing a total of only 5/64" of the chill.

The Mond Nickel Co., Ltd., report the following in another bulletin:*

"An interesting experiment to test the qualities of Ni-Hard was carried out on a pair of high hardness rolls designed for cross rolling nickel silver blanks for electro plate tableware. It was felt that this test would be of interest, as the conditions are relatively severe and plain chilled iron generally fails by spalling under the continually repeated impact. After finish grinding, the rolls manufactured for this test had a surface hardness of 92-94 Shore. In operation these rolls gave an excellent life, whereas a plain chilled iron roll was generally unserviceable after 6 to 8 months' use. The full Ni-Hard rolls after about 2 years, with regrinds at 6 month intervals, were in such good condition that it appeared as if they would have an almost indefinite life, their hardness and surface finish being maintained after each redressing. No sign of spalling developed until one of the rolls was broken due to misuse when an excessively large blank was passed through the mill.

"Reports from other sources confirm the superiority of Ni-Hard rolls for cross rolling, especially in the more arduous service of rolling blanks in stainless steel.

"Sheet and strip mill reports on full Ni-Hard rolls engaged in cold rolling and finishing confirm the economy which has resulted from the larger output obtained per dressing, giving not only increased roll life, but also less shut-down time for roll changing and redressing. One mill in which some 30 full Ni-Hard rolls have now been in service cold finishing tin plate reports on Ni-Hard as follows:

(1) The life of these special rolls is extraordinary long.

(2) The wear on these rolls is slight, and it is possible to use them constantly for from forty to fifty days of twenty hours each after one grinding.
On the contrary ordinary chilled iron rolls are hardly usable for one week's operation after one turning.†

(3) The extreme hardness of the roll surface gives it a great advantage for finishing sheets, in addition to giving a high lustre in the finished product.

(4) Owing to the extreme hardness of the roll, the heat produced by friction, and also the wear on the journals, are very slight."

## ROLLS FOR FINISHING ENAMELING STOCK

For enameling stock, a uniformly rough surface is necessary for assurance of maximum adherence of the enamel. This surface is rolled on the sheets with a roll which has been roughened by sand blasting or acid etching. Many of the large sheet and strip mill producers report that when so prepared the fully alloyed rolls (Types Nos. 1 and 2 in Table IV) maintain this roughened surface longer than hardened steel.

## HOT ROLLING SHEET AND STRIP

Nickel chilled rolls have made their greatest reputation as working rolls in the continuous 3--and 4-high water cooled mills hot rolling sheets and strips. Finish has been such an important factor and service so arduous that plain chilled iron rolls are rarely considered. Hardened steel rolls are not successful because they lack resistance to fire cracking and fail to maintain their hardness at operating temperatures in spite of a copious supply of water. Most generally, freedom from tail marking and orange-peel effect is just as essential in hot rolling as in cold rolling. Aside from finish, the hard alloy rolls are more economical than plain chilled iron rolls in spite of their higher initial cost. Mills which have adopted the alloy rolls have reduced costs by less rejections of sheets, fewer roll replacements, as well as fewer shut-downs for roll changing and redressing. Reports from steel mills show that medium alloy rolls (75-80 Shore), similar to Type No. 3 in Table IV, give four to five times more tonnage between grinds than the ordinary chilled iron rolls hot rolling strip on a 4-high water cooled mill, and fully alloyed rolls (Types Nos. 1 and 2 in Table IV) have given as much as ten times more tonnage than ordinary chilled iron rolls per grind.

The high nickel (4.0-6.0%) alloy work rolls of a continuous mill must be kept cool with a voluminous supply of water in order to obtain maximum quality of finish.

For maximum finish and service, the last or finishing stands have been equipped successfully with fully alloyed rolls (Types Nos. 1 and 2 in Table IV) having a hardness of 85-88 Shore, which is usually slightly less in hardness than rolls for cold rolling.

Medium alloyed rolls (Type No. 3) having 75-85 Scleroscope hardness, have been very successful on intermediate stands. When the hardest rolls in the finishing stands have worn down, they are often shifted back to the intermediate and roughing stands.

Nickel chilled rolls (Type No. 4) containing 2.0-2.50% of nickel have had a long satisfactory record in the roughing stands. In some cases, harder, stronger,

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*Mond Nickel Co., Ltd., Bulletin entitled "Ni-Hard Rolls".

†Turning and grinding means normal turning and grinding of roll surface in lathe after its removal from the stand.

3.0-3.50% nickel chilled rolls are used in these stands when better finish, greater strength and more spall resistance are demanded. Quite frequently rolls from the intermediate stands are used in the roughing stands after they have become unsatisfactory with regard to finish in the intermediate stands. The 2.0-2.50% nickel rolls are not only somewhat harder than plain chilled iron, but they are markedly superior, because their resistance to wear has often been reported to be twice as good, and they possess better core strength and more resistance to spalling.

One mill finishing stainless steel without water on a 2-high mill reported serious breakage trouble with plain chilled rolls. This, however, was eliminated with the adoption of a roll having a composition within the following ranges:

| | |
|---|---|
| Total Carbon.......... | 2.90–3.20% |
| Chromium............ | 0.25–0.35% |
| Nickel................ | 2.00–2.50% |
| Molybdenum.......... | 0.25–0.35% |
| Manganese............ | 0.15–0.20% |

After these rolls become unsuitable for finishing, they are used as roughing and breaking-down rolls.

In some cases rolls with higher than 2.50-3.0% nickel content have been reported to be unsatisfactory for hot dry rolling, as they pit and become rough at temperatures of 700-800°F. which are encountered in the old fashion 2-high tin mills.

## ROLLING SHEET BAR AND PLATE

Demands for better finishes on sheet bar and plate have been increasing so rapidly that the mills have universally adopted alloy chilled rolls for the finishing stands. The most common roll type (No. 4 in Table IV) is the 2.0-2.50% nickel chilled roll containing approximately 0.25% chromium and most generally 0.25% molybdenum. The wear resistance of this roll is generally accepted as better than that of chilled rolls containing various other alloying elements.

When there is spalling trouble with chilled rolls, finish is sacrificed for a more spall resisting grain type alloy roll (similar to Type No. 5 in Table IV) having 2.50-3.0% total carbon, 2.0-3.0% nickel and 0.75-1.25% chromium. They may contain molybdenum up to 0.50% with other adjustments to develop additional shock resistance.

The fully alloyed high-manganese roll (similar to Type No. 2 in Table IV), which has been annealed to a machinable hardness, is rapidly gaining popularity for finishing plate and sheet bar. When cast it has a hardened structure from the surface to the center of the roll, which might require microscopic inspection to determine free graphite in mottle or chill depth. Its surface hardness approaches 90 Shore as cast.

After heat treatment it will have a uniform machinable hardness several inches in depth. The finish produced from this roll is even superior than that from the 2.50% nickel chilled roll, and tonnages between redressings are considerably greater. It also has more strength and spall resistance than the highest alloy grain rolls, and more resistance to fire cracking than any of the rolls described above.

Stands roughing sheet bar and plate may be equipped with 2.50% nickel chilled rolls (Type No. 4 in Table IV) when better finish, more strength and longer life are desired than can be obtained with plain chilled rolls. These stands, however, are most generally equipped with nickel-chromium grain rolls (Types Nos. 5 and 6 in Table IV) because of their greater resistance to breakage and spalling. The fully alloyed high-manganese annealed roll, which has the properties of both the grain and chilled rolls, has been reported to give better service than anything available. Initial higher cost is its only drawback for roughing stands, but when longer life and fewer shut-downs are considered, the extra initial cost is amply recovered during the life of the roll.

## GROOVED ROLLS FOR FLATS, SHAPES AND ROUNDS

Certain flats, such as spring and bumper stock, require such good finishes that chilled rolls better than ordinary iron are used. The majority of them are the low nickel chilled rolls (Type No. 4 in Table IV) having approximately the following composition: 2.00-2.50% nickel, 0.20-0.30% chromium, and 0.20-0.30% molybdenum. Occasionally the nickel is as high as 3.00-3.50% when better finish and service are required. However, the annealed high-manganese roll (Type No. 2 in Table IV) is gaining popularity as it has been reported to give 3 to 4 times more life than ordinary plain and low alloy chilled rolls.

For deep grooved rolls, in which the grooves are machined, it is necessary that the rolls have good depth hardness, high strength and maximum toughness. The foregoing properties are best attained in the annealed high-manganese fully alloyed composition. This roll has been highly satisfactory in the relatively few places that it has been tried. It has extraordinary resistance to wear and fire cracking. Since it has a hardened structure from surface to center as cast, after the annealing treatment the hardness at the bottom of 3 to 4" grooves is approximately the same as its surface hardness. The majority of deep grooved rolls are of the unannealed low alloy grain type. Good depth hardness, high strength and maximum toughness in the grain roll, however, can be produced only by proper alloying. These properties are best obtained with a low total carbon and moderately high alloy content, similar to the following composition:

| | |
|---|---|
| Total Carbon.......... | 2.25–2.75% |
| Nickel................ | 2.75–3.25% |
| Chromium............ | 1.00–1.25% |
| Molybdenum.......... | 0.50–0.75% |

As a matter of economy, when life and finish are secondary, much less alloy than that given above is common. The nickel varies from 0.50 to 2.0% and the chromium from 0.50 to 1.50%.

## ROLLS FOR NON-FERROUS METAL

The earliest application of fully hardened alloyed chill rolls was in the non-ferrous industry, particularly finishing copper and brass sheet and strip.

Requirements for high quality finish in this industry are even greater than in the steel industry. In order to obtain the same finish on non-ferrous material as on steel, a higher quality roll is necessary as small imperfections difficult to see on a visual inspection of the roll will print themselves on soft non-ferrous sheets, though not on the harder ferrous sheets. After a relatively short time of rolling, the soft pearlitic matrix of plain and low alloy chilled rolls is depressed from wear and pressure to such an extent that the carbide network, standing out in relief, prints an orange-peel effect on the sheet. If the matrix is fully martensitic, it resists pressure and wear equally as well as the carbide network and consequently produces a finish on sheets free of the orange-peel effect.

From experience, the definite chill type (No. 1 in Table IV) has proven to give the best finish on soft non-ferrous material. The indefinite chill, high-chromium, high-manganese type, because of a small amount of graphitic carbon in the surface and a relatively coarser structure, has not been as successful in regard to finish as the definite chill type. In the breakdown, roughing, and even in the finishing stands, when only standard finish is required, the indefinite chill type is perhaps superior, as it possesses more strength, rigidity and spall resistance. It has been reported that sheets rolled on 2- and 3-high stands equipped with fully alloyed rolls, either definite or indefinite chill types, have a more uniform gauge than those rolled on plain chilled and hardened steel rolls. This is, no doubt, due to the greater rigidity of the former types.

The application of nickel alloy rolls for rolling ferrous metal plates, sheet bar, flats, shapes and rounds discussed earlier in this paper are equally applicable for corresponding non-ferrous metal rolling.

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## U. S. STEEL ANNOUNCES HUGE PROJECT AT OPENING OF HOMESTEAD PLATE MILLS

Mr. W. A. Irvin, President of the United States Steel Corporation announced that plans have been completed for construction and modernization at the Clairton and Edgar Thomson Works of the Carnegie-Illinois Steel Corporation, involving the expenditure of a sum approaching $60,000,000. The dinner was the climax of a celebration of the opening of the New Homestead Plate Mill of the Carnegie-Illinois Company and approximately 400 guests attended, many coming from distant points.

The construction program for Clairton and Edgar Thomson Works involves:

(1) Construction at Clairton of hot strip and cold reduction mills of the most modern design, of 600,000 tons yearly capacity and electrically operated throughout, for the production of sheet and tin plate. The largest unit will be an 80" hot mill. Approximately $45,000,000 will be spent.

(2) Construction of a new slabbing mill at Edgar Thomson of 1,000,000 tons a year capacity, chiefly to supply slabs to feed the new Clairton mills. Approximately $15,000,000 will be spent.

(3) The addition of extensive electric power producing facilities at Edgar Thomson and necessary transmission lines from Braddock to Clairton where much of the new power will be consumed.

Contracts for this program will be let in the near future.

It is expected that the work will require about fifteen months to complete, indicating the new mills should be in operation in the late Spring or early Summer of 1938.

Reading from left to right: W. A. Irvin, President, U. S. Steel Corporatio Fairless, President, Carnegie-Illinois Steel Corporation; and E. R. Stettin Chairman, Finance Committee, U. S. Steel Corporation, were among th attending the opening of the mill.

Over 500 leaders of industry and members of the press attended the formal opening of the 100" semi-continuous plate mill of the Carnegie-Illinois Steel Corporation, Homestead, Pa. held January 15.

# Steel Plant Power Characteristics

▲ THERE is probably no steel plant in this country that cannot show ,with more or less pride, a collection of data pertaining to power consumptions of mills and other kindred equipment. Fortunately, the electrical manufacturers have from the start, included metering equipment as an essential part of any major installation, so that these measurements are available. In many cases, however, the figures obtained in this way are very incomplete, while in many more cases, the information is used merely for distribution purposes. In too many cases is this true, in spite of the possibility of very considerable savings which might be uncovered by close analysis of power consumption.s

The thorough investigation of power contracts and the subsequent dispatching of power, both of which have proven to pay large returns, almost invariably require an analysis of power consumptions, by units or departments, through a wide range of operations. This, of course, should be done specifically for each plant concerned. It was through work of this kind that the figures set forth in this article were accumulated.

### Coke Plants

By-product coke plants average—1-2 motors per oven, and 20-40 connected H.P. per oven, excluding exhausters and boosters. The latter, if electrically driven, may add 10-15 connected H.P. per oven, but being usually steam driven, will not be included in this data. The above values decrease as the size of plant increases.

Power consumptions in a typical by-product coke plant are about as follows:

| | KWH per Ton of Coal Coked | |
|---|---|---|
| | A.C. | D.C. |
| Ovens and coal handling | 2 | .6 |
| By-product plant | 2 | .1 |
| Benzoil plant and gas purification | 3 | .. |
| | 7 | .7 |

The total power consumption is therefore 7.7 KWH per ton of coal coked, or, if conversion losses of D.C. power be included about 8. KWH per ton of coal. In practice, values are found ranging 6-12 KWH per ton of coal. To this must be added 3-5 KWH per ton of coal coked for water pumping.

Load factors on coke plant loads run 85-90%, while the ratio of average KW to connected H.P. runs 23-28%.

### Blast Furnaces

Blast furnaces may employ 50-70 motors per furnace, totaling 1800-2500 connected H.P. per furnace, values decreasing as the number of furnaces increase. The foregoing does not include electrically driven blowers, the use of which is so rare as to preclude their consideration in this discussion.

Power consumptions of various units of a blast furnace plant run approximately as follows:

| | |
|---|---|
| Skip hoist | 1.7–2.4 KWH/ton of coal |
| D. C. motors, 1.7–2.0 KWH. D. C. @ 75% conversion efficiency | 2.3–2.7 KWH/ton of coal |
| Miscellaneous | .5–1.5 KWH/ton of coal |
| Furnace proper | 4.5–6.5 |
| Ore unloading and handling, .4–.7 KWH D. C. *W* 75% conversion efficiency | .53–.93 KWH/ ton of iron |
| Pig machine, .6–.75 KWH D. C. @ 75% conversion efficiency | .8–1.0 KWH/ton of iron pigged |
| Sinter plant | 12–26 KWH/ton of dry sinter |
| Slag plant | 6– 8 KWH/ton of slag |
| Water pumping | 6–10 KWH/ton of iron produced |
| Total consumption, including pumping | 16–23 KWH/ton of iron |
| Total consumption, excluding pumping | 8–15 KWH/ton of iron |

Load factors of blast furnace plants range 60–75%, and even higher if pumps are included. Ratio of average KW. to connected HP runs 10–14% excluding pumps and 20–25% including pumps.

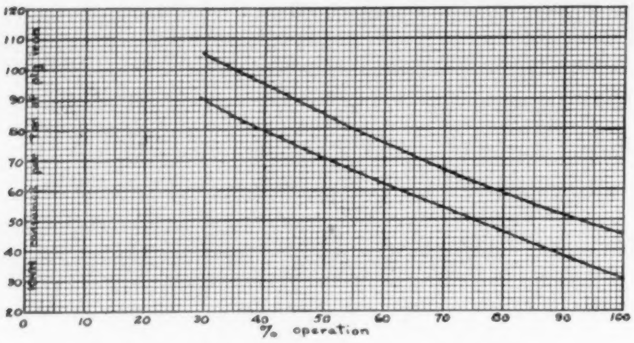


Figure 1—KWH consumed per ton of pig iron.

Figure 1 shows the power consumption of a complete blast furnace plant at various rates of operations. Two curves are given, representing the limits found in the plants investigated. These figures include coke plants, blast furnaces, pumps, auxiliaries and power house, and are based on percentages at which each blast furnace is operated rather than the combined rating of the whole plant. In other words, idle furnaces do not enter into the percent of operations as used here, the figures being based only on furnaces which are active.

**Steel Plants**

Open hearth shops show 15-20 motors per furnace, and average 3-6 connected HP per ton of furnace capacity. Power consumption runs 3-4 KWH of D. C. power per ton of ingots, which at 75% conversion efficiency, gives 4.-5.5 KWH per ton of ingots produced. The ratio of average KW to connected HP is 13–14%.

Bessemer plants consume 5-6 KWH per ton, exclusive of power for blowing. Blowing requirements average 26-33 brake HP per ton of production, which if electrically driven, requires 20-25 KWH per ton.

Power characteristics of rolling mills may vary so widely as to render general figures useless. Power consumptions of rolling mills depend on the type of mill, elongations or degree of reduction, rolling temperature, and rate of operation. However, the figures given in Table I will be found to agree with average practice. Load factors of rolling mills usually fall between 65–85%. (See Table 1)

Electric furnaces also show data varying so widely as to make general figures more or less useless. Power consumption averages 500-550 KWH per ton of steel for melting, and 180-400 KWH per ton for refining, but consumptions vary greatly with size of furnaces and rate of production. Figures between 600-1400 KWH per ton are found, with basic furnaces showing 12–15% higher than acid furnaces. Variation of power consumption with rate of production is indicated by the following:

| Production per Hour | KWH per Ton |
|---|---|
| 500 lb. | 850–1000 |
| 1000 lb. | 750– 850 |
| 1 Ton | 725– 800 |
| 1½ Ton | 665– 750 |
| 3 Ton | 600– 700 |
| 6 Ton | 585– 675 |

TABLE I

Average Power Consumptions of Rolling Mills

| Type of Mill | KWH per Ton of KWH per Ton of Finished Product | | | Ratio Drive Power to Total Power | Ratio Av. Kw. Con. HP |
|---|---|---|---|---|---|
| | Drive | Auxiliaries | Total | | |
| Blooming Mill.... | 15–17 | 6–10 | 22–27 | .65 | 28–30 |
| Billet Mill....... | 16–18 | 2– 4 | 19–20 | .87 | 20–23 |
| Bar Mill......... | 27–33 | 8–10 | 38–48 | .70 | 23–28 |
| Merchant Mill... | 40–50 | 6–8 | 47–59 | .85 | 24–32 |
| Rod Mill........ | 70–80 | 8–12 | 80–90 | .88 | 25–35 |
| Strip Mill........ | 55–65 | 10–12 | 65–76 | .85 | 23–40 |
| Sheet Mill....... | 80–110 | 10–19 | 95–125 | .86 | ..... |
| Plate Mill........ | 35–45 | 10–18 | 50–60 | .73 | 25–27 |
| Sheet Bar Mill... | 20–35 | 2– 5 | 25–40 | .85 | 20–35 |
| Structural Mill... | 30–45 | 4– 8 | 35–50 | .89 | 20–35 |

Size of furnace has been found to affect power consumption approximately as the ratio of KVA of transformer capacity per ton of furnace capacity, which varies somewhat as follows:

| Furnace Capacity Tons | Transformer KVA | Capacity KVA per Ton |
|---|---|---|
| 1 | 500 | 500 |
| 2 | 800 | 400 |
| 3 | 1000 | 330 |
| 4 | 1200 | 300 |
| 6 | 1500 | 250 |
| 10 | 2250 | 225 |
| 15 | 3000 | 200 |
| 25 | 3750 | 150 |

Departmental auxiliaries may add 25-30 KWH per ton of steel produced.

### TABLE II
### Power Characteristics of Typical Electrified Steel Plant

| Unit | Average Consumption KW | Demand KW | KWH per Ton of Product |
|---|---|---|---|
| Total Water Pumping.. | 2500 | 2500 | ..... |
| Coke Ovens........... | 2500 | 2750 | 23.5 |
| Blast Furnaces (3)..... | 800 | 1250 | 8.8 |
| Open Hearths......... | 1200 | 1500 | 12.5 |
| 40″ Blooming Mill<br>24 Billet Mill<br>18 Billet Mill | 7200 | 11000 | 60. |
| 26″ Rail Mill......... | 2000 | 5000 | 48. |
| 60″ Plate Mill......... | 2000 | 4000 | 90. |
| 110″ Plate Mill........ | 1800 | 5000 | 80. |
| Sheet and Jobbing Mill. | 3000 | 3500 | 147 |
| Tin Mills............. | 5500 | 6000 | 250 |
| Shop and Miscellaneous | 1000 | 1500 | .... |
| | 29500 | 44000 | |

**Steel Plant Auxiliaries**

Usual auxiliaries including water supply, air compressors, shops, boiler houses, etc., may create an additional power load of 20-30 KW per ton of open hearth production per hour in a well rounded steel plant. Table II gives power loads of a typical electrified steel plant.

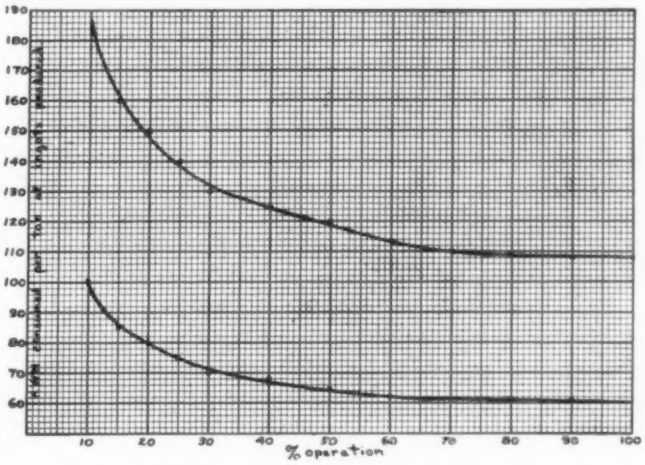


Figure 2—KWH consumed per ton of ingots produced.

Figure 2 gives power consumptions of steel producing units at various rates of operation. These figures are based on percent of open hearth capacity. A rather wide spread is shown between the two limit curves given, which is due to the varying natures of the plants. The lower curve represents a unit consisting merely of open-hearth, blooming mill and billet or sheet bar mill, while the upper one includes also bar and rod mills, as well as considerable auxiliary finishing equipment. It is to be noted, however, that the two curves are very similar in nature.

**Sheet Mills**

Power consumption of hot mill drives may vary with gauge of product as follows:

| | |
|---|---|
| No. 7-12 gauge........... | 60- 90 KWH/finished ton |
| No. 14-20 gauge........... | 80-110 KWH/finished ton |
| No. 20-26 gauge........... | 100-180 KWH/finished ton |

Hot mill auxiliaries, such as cranes, fans, furnaces, etc., add 10-19 KWH per ton.

Complete sheet mill, including finishing operations, range 175-225 KWH per ton of product. From 10 to 15 motors may be employed per hot mill, totaling 350-600 connected HP per hot mill. Of this total, about 55% is found in the hot mill, with 45% in the finishing departments.

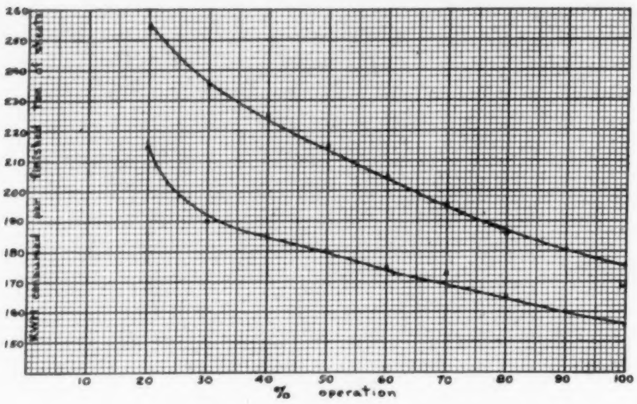


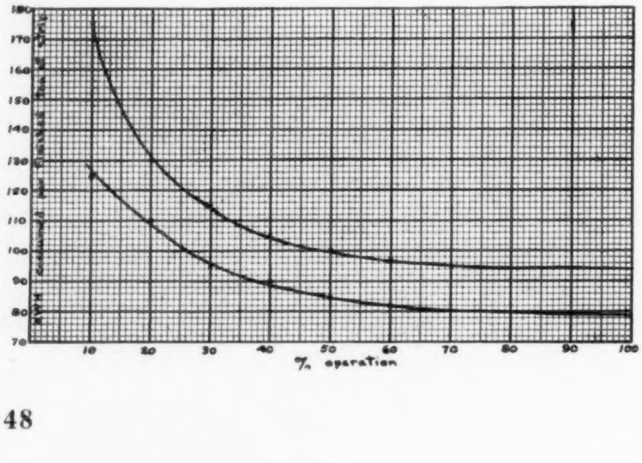
Figure 3—KWH consumed per finished ton of sheets.

Figure 3 and 4 show ranges of power consumptions for sheet and strip mill plants, respectively. Here the spread between limiting curves represents principally the additional equipment for the production of full finished products.

Figure 5 shows the variation of monthly load factor with rate of operation for complete steel plants including all of the foregoing units. A set of curves such as the preceding ,plus power demands, furnish the working data with which all problems of power billings or contracts can be worked out. The characteristics of a power contract can be investigated under various operating rates, or with an estimate of expected tonnages given, the probable monthly billing can be predicted. In setting up curves for a specific plant, however, the power consumption can be plotted against tonnage, rather than against percent of operations as in this article.

It is to be noted that 65-70% seems to be about the best load factor obtainable in practice, representing about 475 hours use of the demand. The operating load factor, however, averages about 75% in a complete plant. Diversity factors of steel plants have been found to average about 1.25.

Figure 4—KWH consumed per finished ton of strip.



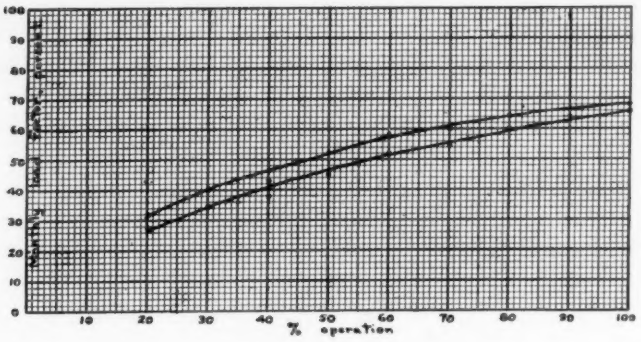


Figure 5—Monthly load factor, percent.

**Miscellaneous Machines**

Power consumptions of various steel plant equipment is given in Table III.

TABLE III
AVERAGE POWER CONSUMPTIONS OF MISCELLANEOUS MACHINES

| Machine | Motor HP | KWH per Department Hr. |
|---|---|---|
| Turning machines...... | 50 | 6–7 |
| Cold saw.............. | 5 | 2–3 |
| Press straightner....... | 3–10 | 2 |
| Straightners, 2″........ | 15 | 8 |
| Straightners, 4″........ | 40 | 30 |
| Straightners, 6″........ | 200 | 75 |
| Cracker shears......... | 10–15 | 3–4 |
| Cut-off machines....... | 5–7.5 | 2.3–3.5 |
| Pointing machines..... | 5–6 | 4–4.5 |
| Lathes, small.......... | 5 | 1.5 |
| Roll lathe............. | 20 | 6 |
| Roll grinder........... | 10 | 5 |
| Sheet shears, single.... | 10–15 | 5–10 |
| Sheet Shears, pack..... | 100 | 35 |
| Roller leveler.......... | 10–15 | 3–5 |
| Stretcher leveler....... | 5 | 3 |
| Sheet oiling machines... | 2–5 | 2 |

# Developments

## IN THE IRON AND STEEL INDUSTRY DURING 1936

W. H. BURR

By W. H. BURR
Chairman A. I. & S. E.
Developments Committee and
Electrical and Mechanical Supt.
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### DEVELOPMENT COMMITTEE REPORT FOR 1936

▲ IF for no other reason the year 1936 will be remembered as the year when the hills and valleys were levelled out in the record of steel mill operations. Such a condition makes possible better working conditions for employees and better operating conditions for the Steel Industry.

From a new low in 1932 the total horse-power installed on main roll drives in the steel industry increased each year until 1935 when it reached 245,700 HP. This was due largely to the installation of new strip mills, for during that year alone there were six hot strip mills installed with a total of 152,150 HP. in motors on main drives, and thirteen cold strip mills equipped with 64,000 HP. in driving units. Naturally after a year, when strip mills almost doubled the then existing capacity, a dip in the curve showing horse-power in motors on main roll drives was to be expected.

During 1936 the new mills installed were diversified, which is after all a more stable condition. There were one hundred eleven main roll drives totalling 208,650 HP. added to the industry during 1936. Complete information regarding these roll drives is published in the accompanying tables.

It may be of interest to note that there are now some 2300 main roll drives in service in the steel industry with a rated capacity of over three and a quarter million horse-power.

### BLAST FURNACES

While not a major development, yet worthy of mention as a safety measure, is a new blow pipe for blast furnaces. Cast iron blow-pipes on blast furnaces frequently crack as a result of great thermal shock. When a blow-pipe fails, the operators nearby may be seriously burned. Moreover, shutdowns for repairs are costly and seriously hold up production schedules.

To meet this situation, a safety blow-pipe has been designed which consists of two tubes, one within the other, the space between the two being filled with insulating material usually an inch or more in thickness.

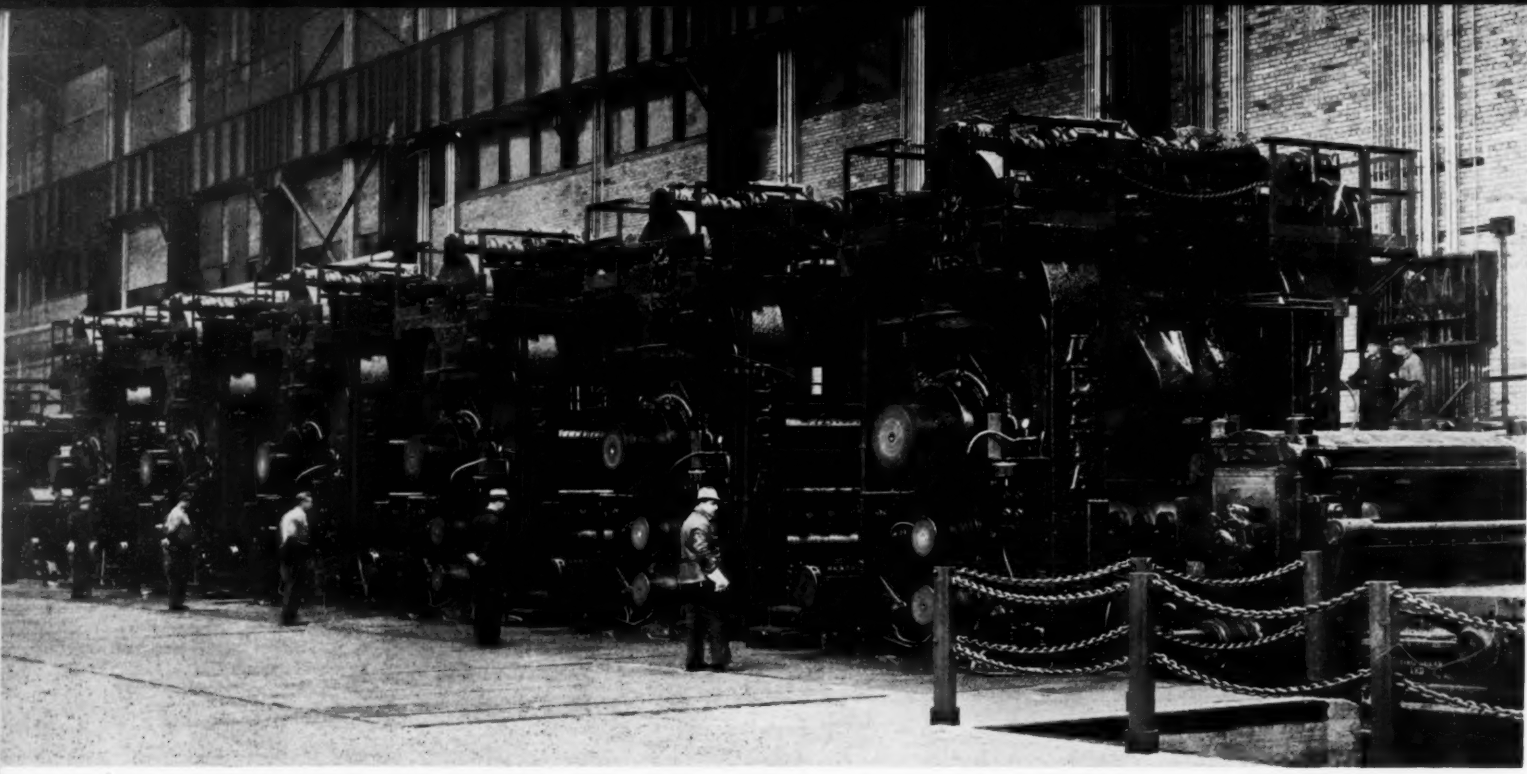
The inner tube or sleeve as well as the end castings are centrifugally cast, heat-resisting metal, an alloy containing thirty-five per cent nickel and fifteen per cent chromium.

The inner sleeve is resistant to scaling or oxidation and acts as a retainer for the insulation. The outer sleeve is a welded tube of plain, open hearth steel. Both are one-quarter of an inch in thickness.

The blow-pipes are of simple design, and are readily interchangeable with the old type iron blow-pipe in common use.

### BOILER ROOM EQUIPMENT

As power requirements increase, boiler room equipment must be developed to meet these conditions,



Finishing stands of the 96" continuous hot strip mill, Great Lakes Steel Corp., Ecorse, Mich., which went into operation this year.

and a number of new installations have been made or contracted for during the current year. The following are some of the more important ones and show very clearly the trend in boiler room practice.

Carnegie-Illinois Steel Company, South Chicago, Illinois—Three 375,000 lb. per hour, 4 drum boilers designed for 550 lb. pressure and 760 F. steam temperature with fin-tube continuous loop economizers; plate type air heaters; water walls. The units will be corner fired, with blast furnace gas as the principal fuel, alalthough two or three burners in each corner will be designed for burning also natural gas, oil or pulverized coal in emergencies.

Great Lakes Steel Corporation (Hanna Furnace Division) Detroit, Michigan,—Three 2-drum steam generators, 450 lb. pressure with superheaters; water walls; air heaters; oil burners and gas burners. The capacity of each unit will be 100,000 lb. of steam per hour when burning oil, and 75,000 lb. per hour when burning blast furnace gas.

Inland Steel Company, Indiana Harbor,—One bent-tube boiler of 250,000 lb. per hour at 300 lb. pressure, having an integral type of economizer.

Carnegie-Illinois Steel Corporation, Youngstown, Ohio,—Two 4-drum bent-tube boilers, each of 150,000 lb. per hour capacity at 500 lb. operating pressure. These will have both plain and fin-tube water walls, plate type air heaters, super-heaters and economizers.

## COMBUSTION INSTRUMENTS

One of the makers of combustion instruments reports the development of a new super-sensitive draft recorder, which has many applications in the steel industry, also an automatic Orsat, for general combustion testing for $CO_2$ and $O_2$, which has many applications in controlled atmosphere and other operations in a steel mill.

Another company reports the following developments. An automatic optical pyrometer which has been applied to measure the temperatures of sheets, rails, rods, welding bands, etc. The introduction of dial adjustments on control instruments, making them much more adaptable to industry's varied requirements. The introduction of air operated control in connection with pyrometry. This has been rendered possible by the use of amplifying pilot valves which has increased the reliability of air control and has made it possible to positively move valves against great resistance. The advance of radiation pyrometry in the steel industry. The increased application of furnace pressure control. The development of electronic combustion safeguards.

Still another instrument maker reports that a new diaphragm operated multi-pointer gage has been developed for boiler room service. Of paramount importance in this new development is its diaphragm material, which is resistant to oil, acid, caustic and heat. It possesses exceptional flexibility with strength far in excess of animal skin and tissues of the goldbeater type.

## RECUPERATORS

One of the outstanding developments reported during the past year in this field is a tubular recuperator which has been applicated to six 50 ton continuous reheating furnaces at Carnegie Illinois Steel Corporation's plants at McDonald, Ohio and Munhall, Pa. The use of exhausters for handling heated air has instituted substantially higher recuperator efficiency than was found possible in previous recuperator design and practice. The slight change necessary in recuperator design to adapt it to suction operation has automatically corrected and prevented abuses that worked against higher efficiency.

The benefits of these developments are found in building as well as operating costs as follows: Reduced size of recuperator, reduced cost of building recuperator, lower cost of foundations, reduction in the cost of furnace as a whole, maintenance of almost constant air temperature at any given furnace rating without the use of automatic temperature control equipment, elimination of leakage by maintaining uniform pressure differences between waste gas and air under all operating conditions within the normal capacity of the recuperator, and use, due to above, of an exhauster of minimum oversize capacity and its operation at maximum efficiency.

## NORMALIZING FURNACES

In May, 1936 there was started up the widest dry shaft normalizing furnace that has yet been constructed. This is at the Great Lakes Steel Plant at Ecorse, Michigan, and the furnace is 9 feet wide inside by 140 feet long. This furnace is likewise fired by the oil gasification system and has been in successful operation now for seven months.

At the time of writing a furnace of this type is just being completed at the Youngstown, Ohio Works of the Republic Steel Corporation, to be used in the annealing (and possibly later the normalizing) of steel tubes. The furnace is 11 feet wide inside by 110 feet long with bearings of quite a large size. This furnace is heated by means of circulating hot air, and for the time being will operate at about 800-1200 deegrees F.

There is also being erected at this time a new normalizing furnace of this inside roller bearing type for the new strip mill of the Jones & Laughlin Steel Corporation in Pittsburgh, Pa. This furnace is substantially the same as the Great Lakes furnace, viz., 9 feet wide inside and just a little shorter than Great Lakes. It will be natural gas fired and will probably be in operation early in 1937.

## PICKLING

To meet certain conditions, there has been developed recently a new type of coil pickler, intended to reduce the labor cost to a minimum, and to attain the same sort of clean pickling produced by the continuous type of installation usually employed by the major companies where large tonnages are involved.

The machine consists essentially of three tanks, and a loading position arranged in a circle, having a radius of approximately 15 feet. A central mast is placed in the center of the circle, and a cross-arm arrangement is mounted on top of the mast. At the end of each arm there is placed a rotating shaft having an acid-proof sprocket. Hanging from each of these sprockets there is an acid-proof chain. The central mast is equipped for raising the weight of four coils of maximum width, or multiple coils of less width, and is also arranged for rotation through progressive arcs of 90 degrees each. The tanks are filled respectively with acid, cold water, and hot water.

In operation, the coils as received from hot mill are run through a 3-roll bending machine, one roll of which is cam equipped, so that a definite spacing of coils is secured. The loosened coil is then delivered to the charging platform of the machine, and an acid-proof mandrel having a diameter of about three-fourths the inside diameter of the loosened coil is inserted through the length of coil by a small traveling carriage. This mandrel is equipped on its ends with acid-proof sprockets, similar to those supported by the over-head arm of the central mast. The chains dangling from these overhead sprockets are then inserted in grooves in the mandrel by the operator, and the coil is then ready for the first step.

During this operation three other coils are in process of being treated; one in the acid, one in the cold water tank, and one in the hot water tank. Upon completion of the pickling operation in No. 1 tank, the mast is raised, lifting all four coils, rotated 90 degrees, advancing each coil progressively to the next position.

The increased demand for higher quality and better finish on many steel products has led to many developments which make possible the handling of the pickling solutions used at the present time. These include all brick masonry tanks, bonded with special bonds, neutralizing pits, brick masonry constructed, all brick masonry sewers to handle acid waste directly from pickling tanks and acid resisting manholes. A plastic acid resisting membrane for lining steel shells, protected by a brick sheathing, is reported by one of the makers of acid resistant materials.

A new pickling inhibitor based upon the acknowledged principle of setting up an electrolytic insulating film where steel is attempting to dissolve, yet at the same time have no retarding effect upon the solution of the scale, has been put on the market. It is a chemically pure product leaving the steel with a clear bright finish. It is a most efficient inhibitor at all pickling ranges and will resist heat and time exposures. The outstanding features are its lasting efficiency and ultimate economy per ton of steel used.

Four High Finishing Train, (4 stands) Carnegie-Illinois Steel Corporation,
New 100 Semi-continuous Plate Mill, Homestead, Pa.
This mill started operations last month.

## BEARINGS

The American Steel & Wire Company have purchased two 19-stand continuous wire mills for installation in their Joilet, Illinois plant. Every one of the rolling mill stands in these mills is equipped with tapered roller bearings. The roughing and intermediate stands employ the conventional four row bearing mounting with the bearings mounted with a loose fit on the roll necks. The 10 finishing stands in each mill, however, make use of a two row bearing which has a tapered bore. This bearing is fitted on a tapered neck and in this way the removal of the bearings for roll changes is greatly facilitated. This tapered neck construction was necessary due to the fact that these finishing stands operate at speeds as high as 1160 revolutions per minute and if the bearings were fitted loose on the necks, considerable trouble would be encountered due to cutting of the necks. This is the first continuous wire mill completely equipped with roller bearings and will consequently be able to illustrate fully the advantages derived from such an application.

Another development which has been made is the design of a standard steep angle high thrust capacity two row bearing with spherical outer races for use on 4 Hi hot and cold mill backup rolls in connection with flood lubricated oil bearings.

During the past year a large number of various sizes of tapered roller bearings for use on hot and cold mill work rolls have been designed. It has been found that bearings made of through hardened steel fail whenever a work roll failure occurs in the mill. However, in the case of bearings which are made of a case carburized steel, the bearings are tough enough to resist the strains imposed due to breakage of work rolls.

It is also reported that many 4 Hi mills built during 1936 were equipped with roller bearings on the screwdowns. This has been due to the fact that one of the makers of roller bearings has been able to supply two row steep angle thrust bearings of sufficient capacity and satisfactory design to absorb the thrusts set up by the worm and screws on the mills.

Considerable trouble has been encountered in the past on piercing mill thrust blocks due to the variation in speed and load encountered when piercing tubes of various sizes. For quite a number of years one of the bearing manufacturers has worked on the design of flat thrust bearings using tapered rolls and races. They have also worked on a design using stacked assemblies of standard tapered roller bearings. During the past year they have developed a high speed flat thrust bearing manufactured with tapered rolls and races which is operating satisfactorily in a great many installations.

Non metallic bearings are receiving careful consideration and the following developments have been reported. Non metallic universal coupling slipper bearings eliminate the noise and vibration incident to the use of metal slippers, all wear is confined to the slipper bearing itself and the companion slipper parts will never require machining once they are placed in good condition. These slippers are lasting from three to nine times that of the metal slippers which they replace. Grease is used as a lubricant and the standard alemite system commonly employed is entirely satisfactory.

Where it is necessary to operate a dry mill or where water used in lubricating the bearing may fall upon the rolls or material prove objectionable, there has been developed a water shield which successfully solves this problem. A number of designs have been developed to accommodate all types of cold rolling mills and provisions are made to compensate for the decreased roll diameter occuring through the wear and subsequent dressing of the rolls.

Non metallic moulded bearings for crane line shaft, track wheel, pulley and bridge wheel bearings have been developed. These bearings have all the desirable characteristics of roll neck bearings and oil or grease is used as a lubricant. Considerable saving in power, and long life under heavy duty are assured. Shaft scoring is eliminated.

Special acid resisting bearings and bushings have been developed for use in continuous galvanizing, pick-

Cold reducing tin plate mill, Bethlehem Steel Company, Sparrows Point, Md., another mill that started operations during 1936.

*Photo by courtesy of Bethlehem Steel Co.*

MESTA
MESTA
MESTA
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2600

ling and scrubbing equipment. Rolls and other auxiliary equipment are made of this acid resisting material.

In the use of non-metallic bearings (water lubricated) on reversing mills it is known that the water film may be destroyed when the mill passes through the reversing cycle and the journal is momentarily at rest. Realizing this condition a special bearing has been developed in which a lubricant has been vulcanized into it to carry on for that short interval of time until the journal again picks up sufficient speed to reestablish the water film and thus completely lubricate the bearings.

One of the pioneer roller bearing manufacturers reported that during the past year they have completely equipped the tables on 80″, 90″, and 96″ strip mills, and also 100″ plate mill with roller bearings. There is also similar equipment on a 35″ and a 46″ blooming mill table job. In hundreds of ingot mold cars; charging box cars; open hearth charging machines; overhead cranes, etc., these bearings have also been installed. In addition to this over 3,000 mill motors equipped with this same type of roller bearings have gone into service.

## LUBRICATION

Each year the importance of proper lubrication becomes more fully recognized and centralized automatic lubrication systems are more generally used. Naturally, with this increase in applications, maintenance problems increase. Complete cooperation between the manufacturers and the users is essential if these problems are to be successfully solved.

In the lubrication field extreme-pressure lubricants and oils are receiving more and more attention. An extreme-pressure lubricant of a consistency suitable for grease guns, application and pressure systems has been reported. It is especially recommended for lubrication of roller bearings as used on roll necks, and for lubricating large roller bearings on slow moving heavy-duty machinery. The type of extreme-pressure treatment used in this lubricant does not promote a falling off of load-carrying capacity as the temperature increases.

Extreme-pressure gear oils include a range of oils designed to meet practically any gear lubrication problem. These oils will withstand three to five times the load of which untreated mineral oils of the same type are capable. These properties are obtained without the addition of material such as sulphur, soaps or acids heretofore used and which commonly separated in service.

Straight cutting and threading oils have been developed that contain a high degree of refrigeration properties plus high film strength. These products include bases which may be diluted with paraffine oil to produce the proper fluidity and obtain the most economical machining costs, also ready-mixed cutting oils.

New greases have been developed for general lubrication purposes in the metal industry. Their reversibility from melting point and freedom from oil bleed, together with their wide adaptability, make them the ideal general purpose solid lubricant for the iron and steel industry.

Continuous strip sheet and plate mill at Lackawanna Plant, Bethlehem Steel Co. Lackawanna, N. Y., which was put in operation the early part of last year.
*Photo by courtesy of Bethlehem Steel Co.*

New demands in metal stamping created a necessity for the development of new drawing compounds. As a result of prolonged research, there has been introduced a new line of steel draws which may be diluted in either water, oil or both. They are "first-aid" products in assisting in smooth flow of steel and lubrication of dies.

## MATERIAL HANDLING

Material handling problems have always been with us but the strip industry has developed many new ones. Much progress has been made, however, as can be seen from the information furnished by the builders of conveying equipment.

The largest single coil upending device yet constructed for the steel industry has been put in service in a continuous strip mill. This unit, incorporated in a line of conveyers, receives coils of steel, changes them from position core axis horizontal to core axis vertical and discharges them at right angles in relation to the direction they were traveling when received. At the point of discharge, the elevation is 2′ 6″ higher than at the point where received. The coils handled by the unit are 4′ 4″ in diameter and 6′ 2″ high indicating a strip 74 inches wide and weigh 25000 lbs.

A 7′ dia. power operated turntable used in the line of conveyers for the purpose of revolving six ton coils of strip steel 90 degrees prior to entering pickling process is now being used. This is driven by a 5 Hp. motor and the coils handled weigh approximately 12,000 pounds.

A chain drive live roller conveyer used in conjunction with a Sutton Tube Straightener is 110 feet long. The steel tubing handled through this straightening device varies in size from 2″ to 7″ in diameter, and in length from 8′ to 26′. A variable speed range of 40′ to 120′ per minute, is required to suit these various sizes. Electric switches which operate kick offs remove lengths of tubing from the conveyers at right angles in its travel, automatically.

A belt driven live roller conveyer is being offered to the steel industry. This belt, which is mounted on pulleys and underneath the rollers which carry the load, is arranged to snub the under side of these rollers causing them to be rotated. This is conventional practice in the conveyer industry when designing packaging conveyer equipment. The driving mechanism can be arranged to be variable affording different surface speeds of such conveyers.

A pneumatically remote controlled upending device used for the purpose of discharging coils from a conveyer line to processing machinery is in actual operation. Operator is stationed adjacent to each of the tilting devices controlling the valves which apply brake mechanisms to the under side of the rollers which tend to hold back other coils of steel while a single coil is being discharged.

A conveyer device equipped with ball bearing fibre tired wheels, called a sheet drier, handles finished sheets. This sheet drier was designed for those mills which must hold finished sheets in storage prior to shipment. During this period of storage, the sheets become dirty and slightly oxidized. Before the steel is shipped, these foreign materials must be removed from the surfaces. The drying device is incorporated in the line of cleaning equipment. The sheets are given an acid bath, run through a scrubbing device, and then pass into the drier. Air ducts throw streams of warm air onto both sides of the sheet and they proceed, cleaned and dried, on a belt conveyer to a piling unit, where they are piled, bound and marked for shipment.

Makers of trucks and tractors report several developments briefly described as follows:

Trucks with heavy duty fork and ram attachments. These trucks are 4-wheel drive and 4-wheel steer, chain lift, forks are quickley interchangeable with ram. Trucks have three speeds forward and three reverse. Operator must be seated before truck can be driven. Brakes are foot operated. With a ram, these trucks handle coiled steel and with forks, handle large sheets. Trucks may be built telescoping if desired.

Heavy duty, 4-wheel drive, 4-wheel steel tractor. Foot operated travel brake. "Fool Proof" interlocking between seat and travel controller prevents trucks from being driven unless operator is seated. It is equipped with a giant Ready-Power unit also recently developed. This tractor has a rated draw bar pull of 3500 pounds.

Conveyor chain platform truck for handling coiled steel. The largest power industrial truck built. Truck is all electrically operated and speeds of platform chains and of truck are governed entirely by foot accelerator. Chains may be operated in sets, that is, either right or left hand set of three chains may be operated while the other set remains stationary. Truck rated capacity is 40,000 pounds.

Elevating ram truck for handling coiled wire from the annealing process to storage. The coils are of course, very hot, so it was necessary to shield the tires with a heavy steel guard. In storage the coils are piled 3-high. The truck itself is built on a standard chasis with special trail axle for 15" x 5" tires. Truck is fitted with controller with carbon to copper contactor which protects controller contacts against sparking and burning. Features also include separate power and brake pedal.

Straight gasoline-powered elevating platform lift tractors in capacities of 3-, 4-, and 5 tons featuring compact design and manouverability equal to that of the standard electric tractors of the same capacities.

Extremely low towing tractors of streamlined design with an overall height of only 42" and suitable for use in tunnels or mines and having the operator seated in a low position where he can couple and uncouple trailers without leaving the seat. These tractors can be furnished with solid, zero-pressure, or pneumatic tires on the driving wheels.

### MAIN ROLL DRIVES

During the last year the design and construction of hot and cold strip mills went on unabated. One hot mill was put in service, capable of producing strip up to ninety-three inches wide and with a delivery speed up to 2000 FPM. A total of 39,000 HP. of main drives has been applied to this mill. Another duplicate hot strip mill is under construction at present and will be started early in 1937. Still another mill, just ordered, will roll strip up to ninety-eight inches wide and will have a maximum delivery speed of 2100 FPM. A total of 39,400 HP. will be used for the main drives of this mill.

Cold strip mill drives have been growing in capacity as the rolling speeds were being raised higher and higher. One 84" tandem mill employs three main DC. motors totalling 6500 HP., as well as a 350 HP. reel motor—probably the largest capacity as yet applied to a cold mill. Several forty-two in. tandem mills are being built to roll tin plate at speeds close to 1500 FPM, and requiring as much as 2750 Hp. to drive the mill stands and the tension reels.

Tension control between the stands of cold strip mills is being recognized more and more as an extremely useful tool. Four mills now under construction are being equipped with tensiometers which record directly the strip tension between the stands and automatically maintain this tension at the desired value.

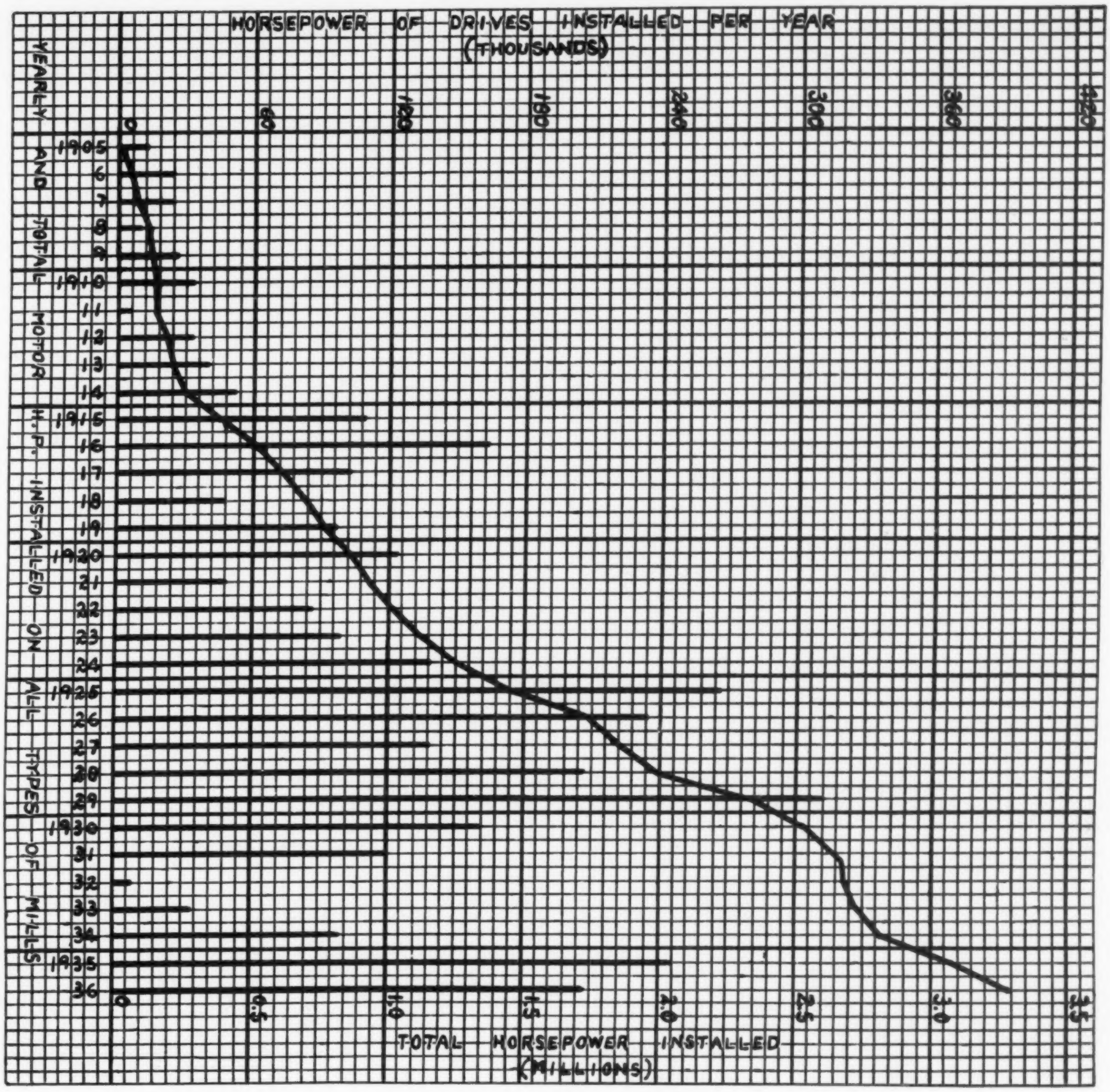
Electrical equipment for skin pass rolling of cold strip (after annealing) is getting more involved. The main rolls, the feed reel and the winding reel are still requiring separate electric drives. In addition to this a so-called "puller" consisting of pinch rolls is located between the mill and either reel. Each puller is separately driven and automatic strip tension control is applied to four out of five driving motors.

Steel mill activities were not limited, however, to strip mills alone. Two 4500 Hp. 400 RPM. synchronous motors were built, each for driving a continuous rod mill. High starting torque with low current inrush were required due to local conditions. The obtained ratio of starting torque to starting Kva is exceptionally high for a 60 cycle machine.

The strip mill activity greatly increased the demand for slabs. A number of new blooming and slabbing mills were built or laid out. Undoubtedly, this activity will extend into 1937.

### AUXILIARY DRIVES

The principal auxiliary drives at a blooming mill, such as screwdowns, live tables, side guards—as well as start-stop bloom shears—were conventionally furnished with power from 250 volt DC. mill supply, and



Total and yearly horsepower installed to Main Roll Drives in the Iron and Steel Industry.

controlled by magnetic control equipment. At one recently installed blooming mill these auxiliary drives were provided with Ward-Leonard control, each drive furnished with power from a separate generator or generators. The latter are of the so-called "shovel generator" type with three fields. This gives the drive a very high light-load speed (particularly advantageous for screwdowns), yet the motors can be safely stalled, without damage to the equipment. The control is very simple and the usual rheostatic losses are eliminated. This installation is already in service and is being watched with great interest by the steel industry.

## WELDING

One of the pioneer makers of welding equipment reports one of the outstanding arc welding development of 1936 is a new method of arc control embodied in the welders which makes possible the adjustment of both arc heat and arc penetration in a continuous sequence of fine increments. It is claimed this refinement assures absolute uniformity of performance at every control setting; it has broadened the range and utility of these machines and it adds greatly to the simplicity of operation.

The new welders are available in the following types and ratings: A.C. motor driven, 200, 300, 400 and 600 amperes. D.C. motor driven, 300, 400 and 600 amperes.

An improved A.C. welding machine converts two phase or three phase alternating current of standard voltage or frequency, into the single phase alternating current of lower voltage and higher frequency necessary for arc welding—a distinct innovation in A.C. welding equipment. Power factor of this A.C. welder is approx-

# ELECTRIC MOTORS OVER 300 H. P.

## APPLIED TO MAIN ROLL DRIVES IN THE IRON AND STEEL AND ALLIED INDUSTRIES DURING THE YEAR 1936

| No. | H.P. | Speed | Voltage | Freq. | Type of Mill | Method of Drive | Purchaser | Location | Mfgd. By |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 300 | 300 | 440 | 25 | 32″ x 96″ Cold Sheet | Geared | Jones & Laughlin Steel Corp. | Pittsburgh, Pa. | G.E. |
| 2 | 300 | 400/1200 | 250 | DC | 12″ Rev. Cold | Geared | Sharon Steel Corp. | Sharon, Pa. | G.E. |
| 3 | 300 | 514 | 440 | 60 | Drive, 4 Cold Mills | Geared | Newport Rolling Mill Co. | Newport, Ky. | A.C. |
| 4 | 300 | 575/1150 | 250 | DC | 42″ Cold Strip Reel | Geared | Youngstown Sheet & Tube Co. | Indiana Harbor, Ind. | W. |
| 5 | 350 | 450/900 | 250 | DC | Aluminum | Geared | Aluminum Goods Co. | Manitowoc, Wis. | G.E. |
| 6 | 350 | 450/900 | 600 | DC | Scale Breaker | Geared | Granite City Steel Co. | Granite City, Ill. | A.C. |
| 7 | 400 | 250/1000 | 250 | DC | 84″ Tempering Pass | Geared | Carnegie-Illinois Steel Corp. | Gary, Ind. | G.E. |
| 8 | 400/300/300/150 | 1200/900/600/450 | 440 | 60 | 10″ Merchant | Geared | Vanadium Alloy Steel Co. | Latrobe, Pa. | G.E. |
| 9 | 500 | 150/600 | 600 | DC | 96″ Hot Strip | Geared | Jones & Laughlin Steel Corp. | Pittsburgh, Pa. | G.E. |
| 10 | 500 | 200/400 | 600 | DC | 98″ Cold Strip | Geared | Republic Steel Corp. | Cleveland, Ohio | W. |
| 11 | 500 | 250/825 | 600 | DC | 42″ Rev. Cold Strip | Geared | Youngstown Sheet & Tube Co. | Indiana Harbor, Ind. | W. |
| 12 | 500 | 250/825 | 600 | DC | 42″ Rev. Cold Strip | Geared | Youngstown Sheet & Tube Co. | Indiana Harbor, Ind. | W. |
| 13 | 500 | 300 | 250 | DC | Rev. Copper Bar | Geared | American Brass Co. | Ansonia, Conn. | G.E. |
| 14 | 500 | 400/535 | 600 | DC | Cold Strip | Coupled | Wheeling Steel Corp. | Yorkville, Ohio | C-W |
| 15 | 500 | 400/800 | 600 | DC | 42″ Tandem Cold Strip | Geared | Carnegie-Illinois Steel Corp. | Gary, Ind. | W. |
| 16 | 500 | 450/900 | 250 | DC | 93″ Single Stand Cold | Geared | Jones & Laughlin Steel Corp. | Pittsburgh, Pa. | G.E. |
| 17 | 500 | 450/1050 | 600 | DC | 42″ Tandem Cold Strip | Geared | Carnegie-Illinois Steel Corp. | Pittsburgh, Pa. | G.E. |
| 18 | 500 | 450/1050 | 600 | DC | 42″ Tandem Cold Strip | Geared | Tennessee Coal, Iron & R. R. Co. | Fairfield, Ala. | G.E. |
| 19 | 500 | 450/1050 | 600 | DC | 42″ Tandem Cold Strip | Geared | Tennessee Coal, Iron & R. R. Co. | Fairfield, Ala. | G.E. |
| 20 | 500 | 500 | 230 | DC | Slab Squeezer—Hot Strip | Coupled | Carnegie-Illinois Steel Corp. | Homestead, Pa. | C-W |
| 21 | 500 | 600/1200 | 600 | DC | 42″ Tandem Cold | Geared | Republic Steel Corp. | Niles, Ohio | G.E. |
| 22 | 600 | 150/600 | 600 | DC | 98″ Hot Strip | Geared | Republic Steel Corp. | Cleveland, Ohio | G.E. |
| 23 | 600 | 250/875 | 600 | DC | 98″ Cold Strip | Geared | Republic Steel Corp. | Cleveland, Ohio | W. |
| 24 | 600 | 400/900 | 600 | DC | Reel Drives | Geared | Granite City Steel Co. | Granite City, Ill. | A.C. |
| 25 | 600 | 400/900 | 600 | DC | Reel Drives | Geared | Granite City Steel Co. | Granite City, Ill. | A.C. |
| 26 | 600 | 600/960 | 300 | DC | 24″ Reversing Cold | Geared | Detroit Steel Corp. | Detroit, Mich. | G.E. |
| 27 | 700 | 505 | 6600 | 60 | Scale Breaker | Geared | Granite City Steel Co. | Granite City, Ill. | A.C. |
| 28 | 800 | 400/800 | 600 | DC | Cold Strip | Geared | Pittsburgh Crucible Steel Co. | Midland, Pa. | W. |
| 29 | 800 | 882 | 2300 | 60 | Sheet | Geared | American Rolling Mill Co. | Huntington, W. Va. | W. |
| 30 | 900 | 200/600 | 600 | DC | Push Bench | Geared | Standard Tube Co. | Detroit, Mich. | G.E. |
| 31 | 1000 | 300/600 | 600 | DC | Vertical Edger | Geared | Granite City Steel Co. | Granite City, Ill. | A.C. |
| 32 | 1000 | 375 | 6600 | 25 | 96″ Hot Strip | Geared | Jones & Laughlin Steel Corp. | Pittsburgh, Pa. | G.E. |
| 33 | 1000 | 400/800 | 600 | DC | 42″ Tandem Cold Strip | Geared | Republic Steel Corp. | Niles, Ohio | G.E. |
| 34 | 1000 | 400/800 | 600 | DC | 42″ Tandem Cold Strip | Geared | Republic Steel Corp. | Niles, Ohio | G.E. |
| 35 | 1000 | 500 | 6600 | 25 | 36″ x 100″ Scale Bkr. Stand | Geared | Carnegie-Illinois Steel Corp. | Homestead, Pa. | G.E. |
| 36 | 1000 | 600/800 | 600 | DC | Cold Strip | Coupled | Wheeling Steel Corp. | Yorkville, Ohio | C-W |
| 37 | 1000 | 600/800 | 600 | DC | Cold Strip | Coupled | Wheeling Steel Corp. | Yorkville, Ohio | C-W |
| 38 | 1000 | 600/800 | 600 | DC | Cold Strip | Coupled | Wheeling Steel Corp. | Yorkville, Ohio | C-W |
| 39 | 1250 | 300/600 | 600 | DC | 42″ Tandem Cold Strip | Geared | Carnegie-Illinois Steel Corp. | Gary, Ind. | W. |
| 40 | 1250 | 300/600 | 600 | DC | 75″ Tandem Cold Strip | Geared | Youngstown Sheet & Tube Co. | Youngstown, Ohio | W. |
| 41 | 1250 | 300/600 | 600 | DC | 42″ Tandem Cold Strip | Geared | Carnegie-Illinois Steel Corp. | Gary, Ind. | W. |
| 42 | 1250 | 300/600 | 600 | DC | 75″ Tandem Cold Strip | Geared | Youngstown Sheet & Tube Co. | Youngstown, Ohio | W. |
| 43 | 1250 | 300/600 | 600 | DC | 42″ Tandem Cold Strip | Geared | Carnegie-Illinois Steel Corp. | Gary, Ind. | W. |
| 44 | 1250 | 300/600 | 600 | DC | 42″ Tandem Cold Strip | Geared | Carnegie-Illinois Steel Corp. | Gary, Ind. | W. |
| 45 | 1250 | 350/585 | 600 | DC | 48″ Cold | Geared | Granite City Steel Co. | Granite City, Ill. | A-C |
| 46 | 1250 | 350/790 | 600 | DC | 42″ Tandem Cold Strip | Geared | Tennessee Coal, Iron & R. R. Co. | Fairfield, Ala. | G.E. |
| 47 | 1250 | 350/790 | 600 | DC | 42″ Tandem Cold Strip | Geared | Tennessee Coal, Iron & R. R. Co. | Fairfield, Ala. | G.E. |
| 48 | 1250 | 350/790 | 600 | DC | 42″ Tandem Cold Strip | Geared | Tennessee Coal, Iron & R. R. Co. | Fairfield, Ala. | G.E. |
| 49 | 1250 | 350/790 | 600 | DC | 42″ Tandem Cold Strip | Geared | Tennessee Coal, Iron & R. R. Co. | Fairfield, Ala. | G.E. |
| 50 | 1250 | 350/790 | 600 | DC | 42″ Tandem Cold Strip | Geared | Tennessee Coal, Iron & R. R. Co. | Fairfield, Ala. | G.E. |
| 51 | 1250 | 350/790 | 600 | DC | 42″ Tandem Cold Strip | Geared | Tennessee Coal, Iron & R. R. Co. | Fairfield, Ala. | G.E. |
| 52 | 1250 | 350/790 | 600 | DC | 42″ Tandem Cold Strip | Geared | Tennessee Coal, Iron & R. R. Co. | Fairfield, Ala. | G.E. |
| 53 | 1250 | 350/790 | 600 | DC | 42″ Tandem Cold Strip | Geared | Tennessee Coal, Iron & R. R. Co. | Fairfield, Ala. | G.E. |
| 54 | 1250 | 350/790 | 600 | DC | 42″ Tandem Cold Strip | Geared | Carnegie-Illinois Steel Corp. | Pittsburgh, Pa. | G.E. |
| 55 | 1250 | 350/790 | 600 | DC | 42″ Tandem Cold Strip | Geared | Carnegie-Illinois Steel Corp. | Pittsburgh, Pa. | G.E. |
| 56 | 1250 | 350/790 | 600 | DC | 42″ Tandem Cold Strip | Geared | Carnegie-Illinois Steel Corp. | Pittsburgh, Pa. | G.E. |
| 57 | 1250 | 350/790 | 600 | DC | 42″ Tandem Cold Strip | Geared | Carnegie-Illinois Steel Corp. | Pittsburgh, Pa. | G.E. |
| 58 | 1250 | 600/800 | 600 | DC | Cold Strip | Coupled | Wheeling Steel Corp. | Yorkville, Ohio | C-W |

| No. | H.P. | Speed | Voltage | Freq. | Type of Mill | Method of Drive | Purchaser | Location | Mfgd. By |
|---|---|---|---|---|---|---|---|---|---|
| 59 | 1500 | 225/450 | 600 | DC | 21″ Continuous Bar | Geared | International Harvester Co. | So. Chicago, Ill. | W |
| 60 | 1500 | 300/600 | 600 | DC | 54″ Tandem Cold Strip | Geared | Jones & Laughlin Steel Corp. | Pittsburgh, Pa. | G.E. |
| 61 | 1500 | 300/600 | 600 | DC | 98″ Tandem Cold Strip | Geared | Republic Steel Corp. | Cleveland, Ohio | W. |
| 62 | 1500 | 300/600 | 600 | DC | 54″ Tandem Cold Strip | Geared | Jones & Laughlin Steel Corp. | Pittsburgh, Pa. | G.E. |
| 63 | 1500 | 300/600 | 600 | DC | 98″ Single Stand Cold Strip | Geared | Republic Steel Corp. | Cleveland, Ohio | W. |
| 64 | 1500 | 300/600 | 600 | DC | 54″ Tandem Cold Strip | Geared | Jones & Laughlin Steel Corp. | Pittsburgh, Pa. | G.E. |
| 65 | 1500 | 300/600 | 600 | DC | 54″ Tandem Cold Strip | Geared | Jones & Laughlin Steel Corp. | Pittsburgh, Pa. | G.E. |
| 66 | 1500 | 300/600 | 600 | DC | 93″ Tandem Cold Strip | Geared | Jones & Laughlin Steel Corp. | Pittsburgh, Pa. | G.E. |
| 67 | 1500 | 300/600 | 600 | DC | 93″ Tandem Cold Strip | Geared | Jones & Laughlin Steel Corp. | Pittsburgh, Pa. | G.E. |
| 68 | 1500 | 300/60 | 600 | DC | 93″ Tandem Cold Strip | Geared | Jones & Laughlin Steel Corp. | Pittsburgh, Pa. | G.E. |
| 69 | 1500 | 300/600 | 600 | DC | 93″ Single Stand Cold | Geared | Jones & Laughlin Steel Corp. | Pittsburgh, Pa. | G.E. |
| 70 | 1500 | 300/600 | 600 | DC | 42″ Tandem Cold Strip | Geared | Republic Steel Corp. | Niles, Ohio | G.E. |
| 71 | 1500 | 300/600 | 600 | DC | Merchant | Geared | International Harvester Co. | So. Chicago, Ill. | W. |
| 72 | 1500 | 300/600 | 600 | DC | Merchant | Geared | International Harvester Co. | So. Chicago, Ill. | W. |
| 73 | 1500 | 300/600 | 600 | DC | Merchant | Geared | International Harvester Co. | So. Chicago, Ill. | W. |
| 74 | 1500 | 300/600 | 600 | DC | 21″ Continuous Bar | Geared | International Harvester Co. | So. Chicago, Ill. | W. |
| 75 | 1500/1250/1000 | 925/750/575 | 2300 | 50 | Single Stand Billet | Geared | Bethlehem Steel Co. | Huntington Park, Cal. | G.E. |
| 76 | 1750 | 400/600 | 600 | DC | 42″ Rev. Cold Strip | Geared | Youngstown Sheet & Tube Co. | Indiana Harbor, Ind. | W. |
| 77 | 2000 | 300/600 | 600 | DC | 21″ Continuous Bar | Geared | International Harvester Co. | So. Chicago, Ill. | W. |
| 78 | 2000 | 300/600 | 600 | DC | 21″ Continuous Bar | Geared | International Harvester Co. | So. Chicago, Ill. | W. |
| 79 | 2000 | 300/600 | 600 | DC | 21″ Continuous Bar | Geared | International Harvester Co. | So. Chicago, Ill. | W. |
| 80 | 2000 | 300/600 | 600 | DC | 21″ Continuous Bar | Geared | International Harvester Co. | So. Chicago, Ill. | W. |
| 81 | 2500 | 225/450 | 600 | DC | 98″ Tandem Cold Strip | Geared | Republic Steel Corp. | Cleveland, Ohio | W. |
| 82 | 2500 | 225/450 | 600 | DC | 90″ Hot Strip | Geared | Granite City Steel Co. | Granite City, Ill. | A-C |
| 83 | 2500 | 225/450 | 600 | DC | 98″ Tandem Cold Strip | Geared | Republic Steel Corp. | Cleveland, Ohio | W. |
| 84 | 3000 | 150 | 6600 | 25 | 96″ Hot Strip | Geared | Jones & Laughlin Steel Corp. | Pittsburgh, Pa. | G.E. |
| 85 | 3000 | 175/350 | 600 | DC | 96″ Hot Strip | Geared | Jones & Laughlin Steel Corp. | Pittsburgh, Pa. | G.E. |
| 86 | 3000 | 375 | 6600 | 25 | 96″ Hot Strip | Geared | Jones & Laughlin Steel Corp. | Pittsburgh, Pa. | G.E. |
| 87 | 3000 | 500 | 6600 | 25 | 96″ Hot Strip | Geared | Jones & Laughlin Steel Corp. | Pittsburgh, Pa. | G.E. |
| 88 | 3000 | 500 | 6600 | 25 | 96″ Hot Strip | Geared | Jones & Laughlin Steel Corp. | Pittsburgh, Pa. | G.E. |
| 89 | 3500 | 150/300 | 600 | DC | 98″ Hot Strip | Direct | Republic Steel Corp. | Cleveland, Ohio | G.E. |
| 90 | 3500 | 175/350 | 600 | DC | Finish Stand—90″ Hot Strip | Geared | Granite City Steel Co. | Granite City, Ill. | A-C |
| 91 | 3500 | 175/350 | 600 | DC | Finish Stand—90″ Hot Strip | Geared | Granite City Steel Co. | Granite City, Ill. | A-C |
| 92 | 3500 | 175/350 | 600 | DC | Finish Stand—90″ Hot Strip | Geared | Granite City Steel Co. | Granite City, Ill. | A-C |
| 93 | 3500 | 175/350 | 600 | DC | Merchant | Geared | International Harvester Co. | So. Chicago, Ill. | W. |
| 94 | 4000 | 75/165 | 700 | DC | 32″ Rev. Blooming | Direct | International Harvester Co. | So. Chicago, Ill. | W. |
| 95 | 4500 | 125/250 | 600 | DC | 98″ Hot Strip | Direct | Republic Steel Corp. | Cleveland, Ohio | G.E. |
| 96 | 4500 | 125/250 | 600 | DC | 96″ Hot Strip | Geared | Jones & Laughlin Steel Corp. | Pittsburgh, Pa. | G.E. |
| 97 | 4500 | 125/250 | 600 | DC | 98″ Hot Strip | Geared | Republic Steel Corp. | Cleveland, Ohio | G.E. |
| 98 | 4500 | 125/250 | 600 | DC | 96″ Hot Strip | Geared | Jones & Laughlin Steel Corp. | Pittsburgh, Pa. | G.E. |
| 99 | 4500 | 125/250 | 600 | DC | 98″ Hot Strip | Geared | Republic Steel Corp. | Cleveland, Ohio | G.E. |
| 100 | 4500 | 125/250 | 600 | DC | 96″ Hot Strip | Geared | Jones & Laughlin Steel Corp. | Pittsburgh, Pa. | G.E. |
| 101 | 4500 | 125/250 | 600 | DC | 98″ Hot Strip | Geared | Republic Steel Corp. | Cleveland, Ohio | G.E. |
| 102 | 4500 | 125/250 | 600 | DC | 96″ Hot Strip | Geared | Jones & Laughlin Steel Corp. | Pittsburgh, Pa. | G.E. |
| 103 | 4500 | 125/250 | 600 | DC | 98″ Hot Strip | Geared | Republic Steel Corp. | Cleveland, Ohio | G.E. |
| 104 | 4500 | 125/250 | 600 | DC | 96″ Hot Strip | Direct | Jones & Laughlin Steel Corp. | Pittsburgh, Pa. | G.E. |
| 106 | 4500 | 400 | 6600 | 60 | Rod | Geared | American Steel & Wire Co. | Joilet, Ill. | G.E. |
| 106 | 4500 | 400 | 6600 | 60 | Rod | Geared | American Steel & Wire Co. | Joilet, Ill. | G.E. |
| 107 | 5000 | 110/250 | 600 | DC | Finish Stand—100″ Cont. Sheared Plate | Geared | Carnegie-Illinois Steel Corp. | Homestead, Pa. | A.C. |
| 108 | 5000 | 110/250 | 600 | DC | Finish Stand—100″ Cont. Sheared Plate | Geared | Carnegie-Illinois Steel Corp. | Homestead, Pa. | A.C. |
| 109 | 5000 | 110/250 | 600 | DC | Finish Stand—100″ Cont. Sheared Plate | Geared | Carnegie-Illinois Steel Corp. | Homestead, Pa. | A.C. |
| 110 | 5000 | 125/265 | 600 | DC | Finish Stand—100″ Cont. Sheared Plate | Geared | Carnegie-Illinois Steel Corp. | Homestead, Pa. | A.C. |
| 111 | 7000 | 50/120 | 700 | DC | 46″ Rev. Blooming | Direct | Inland Steel Co. | Indiana Harbor, Ind. | W. |

# STATISTICS and ANALYSIS
## OF ELECTRIC MOTORS OVER 300 HP

SOLD FOR MAIN ROLL DRIVE SERVICE IN
THE IRON AND STEEL INDUSTRY IN 1936

### APPLICATION OF MOTORS TO VARIOUS TYPES OF MILLS

| Type of Mill | Number | Total Motors | Total Horsepower |
|---|---|---|---|
| Aluminum | 1 | 1 | 350 |
| Copper | 1 | 1 | 500 |
| Blooming | 2 | 2 | 11,000 |
| Billet | 1 | 1 | 1,500 |
| Hot Strip | 4 | 27 | 81,150 |
| Sheared Plate | 1 | 5 | 21,000 |
| Merchant, Bar, Rod | 4 | 13 | 28,400 |
| Cold Strip and Sheet | 15 | 60 | 63,850 |
| Tube | 1 | 1 | 900 |
| | 30 | 111 | 208,650 |

### ANALYSIS OF MOTORS PURCHASED AND THEIR APPLICATION

| Company | Location | Type of Mill | Total Motors | Total Horsepower |
|---|---|---|---|---|
| Aluminum Goods Co. | Manitowoc, Wis. | Aluminum | 1 | 350 |
| American Brass Co. | Ansonia, Conn. | Copper | 1 | 500 |
| American Steel & Wire Co. | Joilet, Ill. | Rod | 2 | 9,000 |
| American Rolling Mill Co. | Huntington, W. Va. | Sheet | 1 | 800 |
| Bethlehem Steel Co. | Huntington Park, Cal. | Billet | 1 | 1,500 |
| Carnegie-Illinois Steel Corp. | Gary, Ind. | Cold | 6 | 5,900 |
| Carnegie-Illinois Steel Corp. | Homestead, Pa. | Sheared Plate | 6 | 21,500 |
| Carnegie-Illinois Steel Corp. | Pittsburgh, Pa. | Cold Strip | 5 | 5,500 |
| Detroit Steel Corp. | Detroit, Mich. | Cold | 1 | 600 |
| Granite City Steel Co. | Granite City, Ill. | Hot Strip | 7 | 15,050 |
| Granite City Steel Co. | Granite City, Ill. | Cold Strip | 3 | 2,450 |
| International Harvester Co. | So. Chicago, Ill. | Merchant | 4 | 8,000 |
| International Harvester Co. | So. Chicago, Ill. | Bar | 6 | 11,000 |
| International Harvester Co. | So. Chicago, Ill. | Blooming | 1 | 4,000 |
| Inland Steel Co. | Indiana Harbor, Ind. | Blooming | 1 | 7,000 |
| Jones & Laughlin Steel Corp. | Pittsburgh, Pa. | Hot Strip | 12 | 39,000 |
| Jones & Laughlin Steel Corp. | Pittsburgh, Pa. | Cold Strip | 10 | 12,800 |
| Newport Rolling Mill Co. | Newport, Ky. | Cold Strip | 1 | 300 |
| Republic Steel Corp. | Niles, Ohio | Cold Strip | 4 | 4,000 |
| Republic Steel Corp. | Cleveland, Ohio | Cold Strip | 6 | 9,100 |
| Republic Steel Corp. | Cleveland, Ohio | Hot Strip | 7 | 26,600 |
| Pittsburgh Crucible Steel Co. | Midland, Pa. | Cold Strip | 1 | 800 |
| Sharon Steel Corp. | Sharon, Pa. | Cold Strip | 1 | 300 |
| Standard Tube Co. | Detroit, Mich. | Tube | 1 | 900 |
| Tennessee Coal, Iron & R.R. Co. | Fairfield, Ala. | Cold Strip | 10 | 11,000 |
| Vanadium Alloy Steel Co. | Latrobe, Pa. | Merchant | 1 | 400 |
| Wheeling Steel Corp. | Yorkville, Ohio | Cold Strip | 5 | 4,750 |
| Youngstown Sheet & Tube Co. | Indiana Harbor, Ind. | Cold Strip | 4 | 3,050 |
| Youngstown Sheet & Tube Co. | Youngstown, Ohio | Cold Strip | 2 | 2,500 |
| | | | 111 | 208,650 |

### TYPES OF MOTORS PURCHASED

| | Total Motors | Total Horsepower |
|---|---|---|
| Alternating Current Motors | 14 | 27,000 |
| Direct Current Motors | 97 | 181,650 |
| | 111 | 208,650 |

imately double that of the former type of welder. It eliminates installation expense and the power drawn from the line is said to be less than with the average D.C. motor generator set.

A new field of welding was opened up by a phosphor bronze arc welding electrode recently developed. The electrode provides a solid homogeneous deposit having the characteristics of true phosphor bronze with notably high tensile strength.

The high quality weld metal produced by the electrode makes it ideal for fabricating new products or reclaiming old ones of bronze, brass or copper. A few of the many applications include: Busbars, large contacts, impeller blades in pumps and turbines, ornamental bronze and bronze doors, etc. Many types of bronzes, which are exceedingly difficult to braze, are readily welded. The electrode is also valuable for welding galvanized sheets where minimum disturbance of the galvanizing is essential.

In reclamation of worn parts of equipment, it is used to build up and fill in bronze castings such as journal boxes and containers, for building up bronze valve seats, bronze bearing surfaces on steel or cast iron, numerous guides, etc.

Steels known as five per cent Chromium Steels, which are rapidly gaining acceptance in applications requiring resistance to crude oil corrosion at high temperatures and pressures, can be successfully welded by use of a new electrode just recently announced.

This electrode permits full development of the valuable properties of the low chromium steels. These steels possess a resistance to sulphide corrosion four to ten times that of ordinary steel and a resistance to oxidation, at 1000 degrees F., three times as great. The electrode contains the essential element of molybdenum and provides weld metal possessing the necessary high creep strength and other qualities essential for welding the five per cent chromium steels.

## CONTROL

Years ago many of us thought that control equipment has reached the limit of perfection, but such has proven to be another of those false conclusions, for each year, many new refinements are being added to control equipment.

The following developments have been reported:

An automatic control including special motor-operated rheostats, bench board type of master station, and a number of magnetic control panels for the complete control of the Cold Strip Continuous Pickling Line from the entry end to the delivery end.

A full automatic control combining and interlocking the operation of a double pair furnace with the roughing mill and including completely automatic screwdown for the roughing mill for sheet mill work.

An air-operated contactor for use in connection with resistance welding, sometimes known as spot welding, and to be used, of course, with the air-operated welders. This development has resulted in the use of air-operated contactors in very large quantities in this particular field.

A safety-anti-repeat power press control for large presses which are operated through the combination of an air clutch brake mechanism.

An A.C. crane hoist control was developed, whereby hoisting and lowering characteristics very similar to DC. dynamic braking could be obtained.

## MERCURY ARC RECTIFIERS

Although the mercury arc rectifier, for converting alternating current to direct current, is now being used extensively in a variety of industries, its value is just beginning to be appreciated in the steel industry. 1000 KW. 250 volt rectifier unit, with auxiliaries, the first application of its kind, was successfully installed this year in a steel mill in the middle west area. It supplies direct current power to a new wire mill, where the major load consists of motors driving the new wire drawing mill.

In order to maintain constant speed on the motor, the direct current voltage at the motor terminals is automatically maintained at a predetermined constant value through the automatic grid control on the rectifier. The quick response of the grid control and the high part load conversion efficiency of the mercury arc rectifier make it ideal for this and other industrial applications. Other similar steel mill installations will undoubtedly follow in the future owing to many inherent advantages.

## CONCLUSION

The year 1937 holds many uncertainties. Prospects for continuous operations at a high rate of total capacity in the steel industry are promising, but there are many problems confronting the industry which will require very skillful handling. The burden of taxation is ever increasing; the labor situation is serious, and the price of raw materials is rapidly advancing. Many developments will, no doubt, be made along lines of social security, and improved working conditions.

The Developments Committee Report for this Association has always been given at its annual meeting, but the trend of the times makes it advisable to change this practice. As a report was given at the last convention in Detroit, this report naturally covers less new developments than under normal conditions.

The information compiled in this report was contributed by members of this committee who have given unstintedly of their time and efforts, and as chairman of this committee, I wish to thank them for having made this report possible.

# STATISTICS and ANALYSIS
# OF ELECTRIC MOTORS OVER 300 HP

## SOLD FOR MAIN ROLL DRIVE SERVICE IN THE IRON AND STEEL INDUSTRY IN 1936

### APPLICATION OF MOTORS TO VARIOUS TYPES OF MILLS

| Type of Mill | Number | Total Motors | Total Horsepower |
|---|---|---|---|
| Aluminum | 1 | 1 | 350 |
| Copper | 1 | 1 | 500 |
| Blooming | 2 | 2 | 11,000 |
| Billet | 1 | 1 | 1,500 |
| Hot Strip | 4 | 27 | 81,150 |
| Sheared Plate | 1 | 5 | 21,000 |
| Merchant, Bar, Rod | 4 | 13 | 28,400 |
| Cold Strip and Sheet | 15 | 60 | 63,850 |
| Tube | 1 | 1 | 900 |
| | 30 | 111 | 208,650 |

### ANALYSIS OF MOTORS PURCHASED AND THEIR APPLICATION

| Company | Location | Type of Mill | Total Motors | Total Horsepower |
|---|---|---|---|---|
| Aluminum Goods Co. | Manitowoc, Wis. | Aluminum | 1 | 350 |
| American Brass Co. | Ansonia, Conn. | Copper | 1 | 500 |
| American Steel & Wire Co. | Joilet, Ill. | Rod | 2 | 9,000 |
| American Rolling Mill Co. | Huntington, W. Va. | Sheet | 1 | 800 |
| Bethlehem Steel Co. | Huntington Park, Cal. | Billet | 1 | 1,500 |
| Carnegie-Illinois Steel Corp. | Gary, Ind. | Cold | 6 | 5,900 |
| Carnegie-Illinois Steel Corp. | Homestead, Pa. | Sheared Plate | 6 | 21,500 |
| Carnegie-Illinois Steel Corp. | Pittsburgh, Pa. | Cold Strip | 5 | 5,500 |
| Detroit Steel Corp. | Detroit, Mich. | Cold | 1 | 600 |
| Granite City Steel Co. | Granite City, Ill. | Hot Strip | 7 | 15,050 |
| Granite City Steel Co. | Granite City, Ill. | Cold Strip | 3 | 2,450 |
| International Harvester Co. | So. Chicago, Ill. | Merchant | 4 | 8,000 |
| International Harvester Co. | So. Chicago, Ill. | Bar | 6 | 11,000 |
| International Harvester Co. | So. Chicago, Ill. | Blooming | 1 | 4,000 |
| Inland Steel Co. | Indiana Harbor, Ind. | Blooming | 1 | 7,000 |
| Jones & Laughlin Steel Corp. | Pittsburgh, Pa. | Hot Strip | 12 | 39,000 |
| Jones & Laughlin Steel Corp. | Pittsburgh, Pa. | Cold Strip | 10 | 12,800 |
| Newport Rolling Mill Co. | Newport, Ky. | Cold Strip | 1 | 300 |
| Republic Steel Corp. | Niles, Ohio | Cold Strip | 4 | 4,000 |
| Republic Steel Corp. | Cleveland, Ohio | Cold Strip | 6 | 9,100 |
| Republic Steel Corp. | Cleveland, Ohio | Hot Strip | 7 | 26,600 |
| Pittsburgh Crucible Steel Co. | Midland, Pa. | Cold Strip | 1 | 800 |
| Sharon Steel Corp. | Sharon, Pa. | Cold Strip | 1 | 300 |
| Standard Tube Co. | Detroit, Mich. | Tube | 1 | 900 |
| Tennessee Coal, Iron & R.R. Co. | Fairfield, Ala. | Cold Strip | 10 | 11,000 |
| Vanadium Alloy Steel Co. | Latrobe, Pa. | Merchant | 1 | 400 |
| Wheeling Steel Corp. | Yorkville, Ohio | Cold Strip | 5 | 4,750 |
| Youngstown Sheet & Tube Co. | Indiana Harbor, Ind. | Cold Strip | 4 | 3,050 |
| Youngstown Sheet & Tube Co. | Youngstown, Ohio | Cold Strip | 2 | 2,500 |
| | | | 111 | 208,650 |

### TYPES OF MOTORS PURCHASED

| | Total Motors | Total Horsepower |
|---|---|---|
| Alternating Current Motors | 14 | 27,000 |
| Direct Current Motors | 97 | 181,650 |
| | 111 | 208,650 |

imately double that of the former type of welder. It eliminates installation expense and the power drawn from the line is said to be less than with the average D.C. motor generator set.

A new field of welding was opened up by a phosphor bronze arc welding electrode recently developed. The electrode provides a solid homogeneous deposit having the characteristics of true phosphor bronze with notably high tensile strength.

The high quality weld metal produced by the electrode makes it ideal for fabricating new products or reclaiming old ones of bronze, brass or copper. A few of the many applications include: Busbars, large contacts, impeller blades in pumps and turbines, ornamental bronze and bronze doors, etc. Many types of bronzes, which are exceedingly difficult to braze, are readily welded. The electrode is also valuable for welding galvanized sheets where minimum disturbance of the galvanizing is essential.

In reclamation of worn parts of equipment, it is used to build up and fill in bronze castings such as journal boxes and containers, for building up bronze valve seats, bronze bearing surfaces on steel or cast iron, numerous guides, etc.

Steels known as five per cent Chromium Steels, which are rapidly gaining acceptance in applications requiring resistance to crude oil corrosion at high temperatures and pressures, can be successfully welded by use of a new electrode just recently announced.

This electrode permits full development of the valuable properties of the low chromium steels. These steels possess a resistance to sulphide corrosion four to ten times that of ordinary steel and a resistance to oxidation, at 1000 degrees F., three times as great. The electrode contains the essential element of molybdenum and provides weld metal possessing the necessary high creep strength and other qualities essential for welding the five per cent chromium steels.

## CONTROL

Years ago many of us thought that control equipment has reached the limit of perfection, but such has proven to be another of those false conclusions, for each year, many new refinements are being added to control equipment.

The following developments have been reported:

An automatic control including special motor-operated rheostats, bench board type of master station, and a number of magnetic control panels for the complete control of the Cold Strip Continuous Pickling Line from the entry end to the delivery end.

A full automatic control combining and interlocking the operation of a double pair furnace with the roughing mill and including completely automatic screwdown for the roughing mill for sheet mill work.

An air-operated contactor for use in connection with resistance welding, sometimes known as spot welding, and to be used, of course, with the air-operated welders. This development has resulted in the use of air-operated contactors in very large quantities in this particular field.

A safety-anti-repeat power press control for large presses which are operated through the combination of an air clutch brake mechanism.

An A.C. crane hoist control was developed, whereby hoisting and lowering characteristics very similar to DC. dynamic braking could be obtained.

## MERCURY ARC RECTIFIERS

Although the mercury arc rectifier, for converting alternating current to direct current, is now being used extensively in a variety of industries, its value is just beginning to be appreciated in the steel industry. 1000 KW. 250 volt rectifier unit, with auxiliaries, the first application of its kind, was successfully installed this year in a steel mill in the middle west area. It supplies direct current power to a new wire mill, where the major load consists of motors driving the new wire drawing mill.

In order to maintain constant speed on the motor, the direct current voltage at the motor terminals is automatically maintained at a predetermined constant value through the automatic grid control on the rectifier. The quick response of the grid control and the high part load conversion efficiency of the mercury arc rectifier make it ideal for this and other industrial applications. Other similar steel mill installations will undoubtedly follow in the future owing to many inherent advantages.

## CONCLUSION

The year 1937 holds many uncertainties. Prospects for continuous operations at a high rate of total capacity in the steel industry are promising, but there are many problems confronting the industry which will require very skillful handling. The burden of taxation is ever increasing; the labor situation is serious, and the price of raw materials is rapidly advancing. Many developments will, no doubt, be made along lines of social security, and improved working conditions.

The Developments Committee Report for this Association has always been given at its annual meeting, but the trend of the times makes it advisable to change this practice. As a report was given at the last convention in Detroit, this report naturally covers less new developments than under normal conditions.

The information compiled in this report was contributed by members of this committee who have given unstintedly of their time and efforts, and as chairman of this committee, I wish to thank them for having made this report possible.

# ELECTRICALLY OPERATED CRANE STATISTICS---1936

## ELECTRIC OVERHEAD TRAVELING CRANES, CHARGERS, PURCHASED BY IRON AND STEEL INDUSTRY

### TABLE NO. 1

### TYPES OF CRANES PURCHASED

| | |
|---|---|
| Standard Cranes | 75 |
| Gantry | 3 |
| Pit Cranes | 5 |
| Mill Type Cranes | 59 |
| Ladle | 7 |
| Special Underhung | 3 |
| Special | 3 |
| Wall | 1 |
| Grab Bucket | 4 |
| Low Headroom | 2 |
| Trolley | 14 |
| Special Retort Handling | 1 |
| Special Cleaning House | 1 |
| Slab Handling | 2 |
| Stripper | 2 |
| Bridge | 2 |
| Floor Charging | 2 |
| | 186 |

### TYPE OF GEARING

| | |
|---|---|
| Cranes Equipped with Spur Gears | 131 |
| Spur and Worm Gears | 19 |
| Spur and Herringbone Gears | 11 |
| Worm Gears | 24 |
| Helical Gear | 1 |
| | 186 |

### COMPILATION

| | |
|---|---|
| Total Cranes Purchased | 186 |
| Cranes completely equipped with Anti-Friction Bearings | 142 |
| Cranes partially equipped with Anti-Friction Bearings | 18 |
| Cranes equipped with Plain Bearings | 26 |
| Trolleys Purchased | 14 |
| Trolleys completely equipped with Anti-Friction Bearings | 11 |
| Trolleys partially equipped with Anti-Friction Bearings | 2 |
| Trolleys equipped with Plain Bearings | 1 |
| Bridges Purchased | 2 |
| Bridges completely equipped with Anti-Friction Bearings | 1 |
| Bridges equipped with Plain Bearings | 1 |
| Trolleys with Spur Gears | 12 |
| Trolleys with Worm and Spur Gears | 1 |
| Trolleys with Worm Gears | 1 |
| Motors furnished | 508 |
| Total Tonnage purchased | 5593½ |
| Cranes, Trolleys Using DC Current | 178 |
| Cranes, Trolleys Using AC Current | 8 |

### TABLE NO. 2

### TREND OF BEARING CONSTRUCTION

| No. of Cranes | Crane Tonnage | Completely Equipped with Anti-Friction Bearings | Partially Equipped | Plain Bearings |
|---|---|---|---|---|
| 5 | 2 | 3 | 2 | .. |
| 2 | 4 | 1 | .. | 1 |
| 18 | 5 | 14 | 1 | 3 |
| 3 | 6 | 2 | .. | 1 |
| 3 | 7½ | 2 | .. | 1 |
| 32 | 10 | 24 | 7 | 1 |
| 39 | 15 | 34 | 2 | 3 |
| 26 | 20 | 23 | 1 | 2 |
| 8 | 25 | 7 | .. | 1 |
| 6 | 30 | 3 | .. | 3 |
| 1 | 35 | 1 | .. | .. |
| 2 | 37½ | 2 | .. | .. |
| 4 | 40 | 4 | .. | .. |
| 2 | 45 | 2 | .. | .. |
| 7 | 50 | 4 | 1 | 2 |
| 2 | 55 | 2 | .. | .. |
| 8 | 60 | 4 | 1 | 3 |
| 1 | 65 | 1 | .. | .. |
| 1 | 70 | 1 | .. | .. |
| 5 | 75 | 5 | .. | .. |
| 1 | 100 | ... | .. | 1 |
| 4 | 125 | 2 | 1 | 1 |
| 1 | 130 | ... | .. | 1 |
| 3 | 200 | ... | 2 | 1 |
| 2 | 250 | 1 | .. | 1 |
| 186 | | 142 | 18 | 26 |

### TROLLEYS PURCHASED

| No. of Cranes | Crane Tonnage | Completely Equipped with Anti-Friction Bearings | Partially Equipped | Plain Bearings |
|---|---|---|---|---|
| 3 | 5 | 2 | 1 | .. |
| 1 | 6 | ... | 1 | .. |
| 1 | 7½ | ... | .. | 1 |
| 4 | 10 | 4 | .. | .. |
| 1 | 15 | 1 | .. | .. |
| 2 | 20 | 2 | .. | .. |
| 1 | 30 | 1 | .. | .. |
| 1 | 70 | 1 | .. | .. |
| 14 | | 11 | 2 | 1 |

### BRIDGES PURCHASED

| No. of Cranes | Crane Tonnage | Completely Equipped with Anti-Friction Bearings | Partially Equipped | Plain Bearings |
|---|---|---|---|---|
| 1 | 10 | ... | .. | 1 |
| 1 | 15 | 1 | .. | .. |
| 2 | | 1 | | 1 |

# Developments in Welding During 1936

By GROVER A. HUGHES,
Electrical Engineer
Truscon Steel Company
YOUNGSTOWN, OHIO

**Presented before the Annual Convention of the A. I. & S. E., Detroit, Michigan, September 22-25, 1936**

▲ IT is not intended that this paper shall completely cover the broad subject of "Development of the Art of Welding" for the past year but to outline some of the important outstanding achievements and developments of the past year in the field of welding. The experiments of today of our engineers and research men become the theory of tomorrow. Sometimes theory and practice will disagree. When such disagreements are carefully checked it nearly always shows all the variables of the theory are not included in the practice. The difficult part of research is the application of the result to practice. Too often the research man is hampered by outside influences who fail to comprehend the problems at hand. Blinded by the urgent call of the needs of industry for the product of his research. Oft times the research is not complete because of inadequate equipment to carry on the research and resulting in dropping of very valuable ideas which otherwise would be of great benefit to industry and Society.

A better understanding between the technical and practical man will assist in avoiding the pitfalls so commonly encountered.

In the past few years all research in welding was confined to the laboratories of large industrial corporations manufacturing welding equipment and to our universities whose students were working out their thesis or advanced degrees. Such research is complete in every detail and is available to industry.

However considerable research has been made by individuals in industry valuable indeed and not generally known because the individual making the research was more or less isolated by his inability to present his work.

No event has ever occurred in the history of industry greater in magnitude or which has drawn to it more intense interest, than "Welding."

This youngest branch of industry has more than thirty thousand employed either in manufacture of welding equipment, supplies, sales or operators. The total load of over one hundred thousand K.V.A. is a very desirable one for our control stations, in earning dividends for stockholders and further furnishing employment.

Much has been written on this subject but the author would surely be presumptious to imagine he could fully cover the ground as to the far reaching influence of the art of welding in industry.

The Research man of the present day has an easy task, compared with his predecessors. Much that was then obscure has now become clear. Much also was written of research which in the hurry and anxiety to get the literature of the research into the market, was erroneous.

Industry has long felt the need for a suitable committee to formulate a comprehensive, coordinated program of welding research.

The American Institute of Electrical Engineers and the American Welding Society have organized and are sponsoring a welding research committee consisting of nine nationally known engineers engaged in the field of welding.

Committee:

- C. A. Adams (Chairman) Professor Electrical Engineering, Harvard University.
- J. H. Critchett (V. Pres.) Union Carbide Research Laboratory.
- J. J. Crowe, Eng. in Charge Research, Air Reduction Sales.
- C. L. Eksergran, Chief Engr. Budd Company.
- H. M. Hobart, Consulting Engineer, General Electric Company.
- D. S. Jacobus, Advisory Engr. Babcock-Wilcox Company.
- Col. G. F. Jenks, Commanding Officer, Watertown Arsenal.
- F. T. Llewellyn, Research Engr., U. S. Steel Corporation.
- W. Sparagen, Consulting Engr., Sec. of Comm.

To better understand the workings of this Welding Research Committee, their program, etc., I take the liberty to quote in part from the report of that committee.

"The work has been divided among three sub-committees:

(a) Literature—J. H. Critchett, Chairman.
(b) Fundamental Research, H. M. Hobart, Chairman.
(c) Industrial Research, G. F. Jenks, Chairman.

### REVIEW OF LITERATURE

One of the first steps is a comprehensive critical summary of research results and experience as reported in the technical literature of the world. Monographs are to be prepared which will provide a reliable foundation for further research, and supply to welding metallurgists, engineers and foremen, the essential information now scattered through several thousand journals and text books in many languages.

A card bibliography has been assembled which now totals about 15,000 references. A classification system has been prepared. Abstracts have been made of the important available literature published in French, Italian and Spanish. Critical digests have been made of a few select subjects. Further divisions of the work will be made and assigned to experts. A competent editor will be employed.

### FUNDAMENTAL RESEARCH

This sub-committee had the advantage of several years progress in interesting sixty important universities in fundamental problems progress has been made in interesting additional universities. During the summer of 1936, the committee expects to compile a list of fundamental research problems needing investigation, to be amplified by selected bibliographical references.

A system for making translations of important foreign articles has been established. At least a dozen important foreign articles have been translated and made generally available. This represents a contribution in kind amounting to about one thousand dollars.

A successful conference of interested university workers was held in Chicago in October 1935 at the time of the fall meeting of the American Welding Society and the Metal Congress Exposition. Another conference was held in October 1936 in Cleveland.

Funds are needed to provide an assistant to the committee and to permit small grants-in-aid to specific investigators for the purchase of materials, apparatus and some service where these grants will materially expedite progress."

This is a big task undertaken by the sponsors and to make it a success, industry and all individuals interested in the art of welding should assist in the enterprise. The sponsors are indeed worthy of whole hearted support in their new field of endeavor.

### EDUCATION

Many of our universities are holding Welding Symposiums and Welding Conferences for the general public in an endeavor to bring to the attention of the layman and small industrial plants the great possibilities of better products of welding.

Many of the trade schools offer a practical course in welding training the student to become a welding operator. Such courses usually are of six weeks and a very nominal fee is charged.

Some of the manufacturers of arc welding equipment conduct a similar school.

The U. S. Navy has long realized the need of highly trained technical men for welding design and construction work. A set up is now made with some of our universities and technical schools for a two year course for men selected from the graduating class at Annapolis. This two year course leads to a Masters Degree in Engineering.

Many of our large industrial corporations are conducting welding schools for training men for their particular needs.

The manufacturers of Welding equipment maintain laboratories for development of their equipment and are assisting the fabricator in solving his problems.

The American Welding Society's records show over two hundred cities permit welding in some form in their building codes.

The railroads and State Highway Departments are strengthening and repairing their bridges by some form welding and in many cases traffic is not disturbed. One instance is the Williamsburg bridge, New York City from Manhattan to Long Island over the East River.

One of the outstanding achievements of the past year of the Truscon Steel Co. is the fabricating of vertical radiators for broadcasting stations by welding. These radiators are generally self supporting, slender and raise to great heights. Station KGHL, Billings, Montana is 558 feet in height. KOMO, Seattle, Washington, 570 feet. One in Canton, China, 622 feet and a station at Tallin, Esthonia, is 645 feet.

The latest vertical radiator which is causing quite an interest in the radio broadcasting field is the new KDKA station at Saxonburg, Pa., raising to the heights of over 710 feet. It has many unique features of design made possible only by welding.

I will leave the story of the design, construction and performance to the purchaser, as we are only interested in this Radiator as it was entirely fabricated by welding and is the tallest structure so fabricated to date.

### WELDING MACHINES

Resistance Welding is a production tool and special machines appear from time to time employing the same general theory of design only changing physical form to meet the problems at hand.

Several of the manufacturers of Arc Welding equipment have placed on the market recently machines of new designs. Of their merits I do not care to discuss other than to say, they possess fewer gadgets to get out of order, which in my way of thinking is an improvement.

Many new Welding electrodes have appeared the past year with various claims from the manufacturer in the heavy fluxed coated and washed rods of superior qualities of deposited metal over their former rods.

During the past year, weld timers for accurately timing the welding period of resistance welders have been greatly improved. The Welding period can now be controlled to a part of a cycle using 60 cycle current. The heat controll can be accurately determined at the same time by changing the form of the sine wave, thus completely covering all phases of resistance welding timing.

The changes in development of the various phases of welding methods and design have been so many and rapid during the past year, that our leading periodicals on the subject are about six months behind the latest developments. With so many research engineers interested, what the future has in store for us, no one can predict.

# Items of Interest

**Myron A. Wick,** vice president of Republic Steel Corp., has been elected president of Truscon Steel Steel Co., Republic subsidiary, it was announced recently by Republic. Mr. Wick succeeds A. E. Walker, formerly president of Trucson and general manager of sales for Republic, who has left Republic to become executive vice president of the Pittsburgh Steel Co.

▲

**J. M. Schlendorf,** recently appointed assistant vice president in charge of sales, Republic Steel Corp., has been with the corporation since its organization in 1930. He joined Central Steel Co., Massillon, in 1917 as vice president in charge of sales and when the Central Alloy Steel Corp. was organized in 1926, he remained with the new company in the same position. Previously, he was in the sales department of the American Sheet & Tin Plate Co. Mr. Schlendorf has a nation-wide acquaintance among buyers and users of alloy steels. His new headquarters will be in Cleveland.

▲

**Norman W. Foy,** has been named general manager of sales, succeeding A. E. Walker ,who resigned to become executive vice president of the Pittsburgh Steel Co. Mr. Foy, who was born in Baltimore, started in the steel industry at the age of 16 and has spent his entire business life with steel companies with the exception of one year during the War when he was a first lieutenant in the Engineers. After spending five years in the Baltimore sales office of the Carnegie Steel Co., he joined Republic Iron & Steel Co. in 1918 as a salesman in its Philadelphia office. In succession he was in charge of the Company's Philadelphia, Boston, Buffalo, Birmingham, and Chicago offices and in 1934 was brought to the general offices of Republic Steel Corp. as assistant general sales manager.

**Frederick H. Loomis,** has been appointed assistant general manager of sales. He was graduated from Williams College in 1911, after which he joined Republic Rubber Co. of Youngstown as a salesman, later becoming district sales manager at the Minneapolis office. In 1916 he became associaetd with the Trumbull Steel Co. and was successively salesman, district sales manager, assistant general manager of sales, and general manager of sales. In 1928, when Trumbull Steel merged with Republic Iron & Steel, he was made assistant general manager of sales. Mr. Loomis spent a year and a half in the navy during the war, starting as an enlisted man and was commissioned an Ensign before his resignation.

▲

**William J. Sampson,** has been appointed assistant general manager of sales. He was graduated from Yale in 1920 and became associated with Steel & Tubes. He began his active work in the mills and from there was transferred to the sales department. He was later manager of a plant in Toledo, then operated by the company, and came back to Cleveland as vice president.

▲

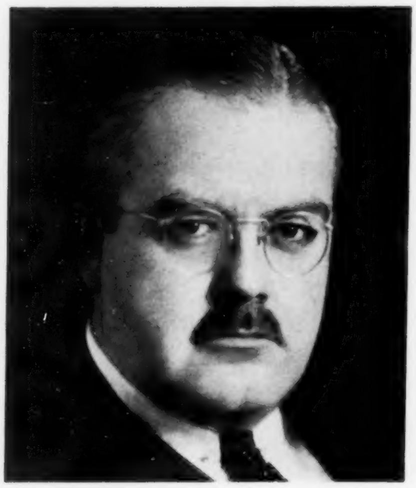
**Martin H. Schmid,** formerly assistant manager of sales, Alloy Steel Division, Massillon, has been appointed manager of sales succeeding J. M. Schlendorf.

Mr. Schmid graduated from Lehigh University as a mechanical engineer and has been with Republic Steel Corp. and its predecessor companies since 1909. He started with the United Alloy Steel Co. in Canton as assistant master mechanic, then became metallurgical engineer and assistant manager of sales. In 1926, following the merger with Central Alloys Co., he became assistant manager of the bar department and after that company's merger with Republic Steel Corp., assistant manager of sales of the Alloy Steel Division. Mr.Schmid will have as assistant managers Gordon F. Hess and Clyde E. Roberts.

J. M. SCHLENDORF

NORMAN W. FOY

FREDERICK H. LOOMIS



WILLIAM J. SAMPSON

**John V. Burley,** who has been assistant manager of sales, Sheet and Strip Division, will succeed Frederick H. Loomis as manager of sales, Sheet and Strip Division.

Mr. Burley entered the steel industry in 1917 when he became associated with the Detroit district sales office of the Midvale Steel & Ordinance Co., remaining with Bethlehem Steel Co. after the Midvale-Bethlehem in 1925. He then joined the Trumbull Steel Co. in its Detroit district sales office and in 1930 opened a Toledo sales office for Republic Steel Corp. He was brought into the sales headquarters in 1932. J. W. Carpenter will continue as assistant manager of sales, Sheet and Strip Division.

▲

**J. Ledlie Miller** has been named assistant combustion engineer of Republic Steel Corp., C. M. White, vice president in charge of operations, announced recently. Mr. Miller, assistant chief engineer of Carnegie-Illinois Steel Corp., from 1928 to 1936 in the Youngstown district, will have his headquarters in Cleveland.

J. LEDLIE MILLER

A native of Wellsburg, W. Va., Mr. Miller has been employed in the steel industry since 1909, serving as messenger, draftsman, and in the experimental engineering department of Carnegie Steel until he joined the Army, where he served over seas as lieutenant in the heavy field artillery. Serving as fuel engineer at the Bellaire works of Carnegie from March 1919 until the steel strike that fall, he returned to the Carnegie Institute of Technology where he received his degree in mechanical engineering the following year.

Mr. Miller returned to Bellaire as fuel engineer and when this plant was closed, went to the Follansbee Brothers plant in Toronto, where he was annealing department foreman and assistant metallurgist until January 1, 1925. He served as fuel engineer of the Wheeling Steel Corp. in the Wheeling district from 1925 until he went to Youngstown for Carnegie in 1928.

Mr. Miller is an active member of the A.I. & S.E. and is at present secretary of the society.

▲

**The United Engineering & Foundry Company,** Pittsburgh, Pa., announces the following changes in personnel that became effective January 1, 1937:

**Howard H. Talbot** will assume the title of Senior Engineer with duties of General Engineering Consultant.

**Maurice P. Sieger,** now Assistant Chief Engineer, will assume the title and duties of Chief Engineer.

**J. W. O'Brien,** who is now assisting Mr. Sieger, will assume the title and duties of Assistant Chief Engineer.

**G. G. Beard,** while continuing in charge of Proposal Engineering, will be supported by Mr. Talbot so as to enable his devoting himself largely to Sales Engineering.

**Dr. Morris Stone** will be in charge of new Engineering Development Division.

**F. C. Biggert, Jr.,** who relinquishes the title of Senior Engineer, will continue as Vice President in general charge of Engineering and Research.

▲

**W. R. Brown,** Managing Director of the Old Castle Iron and Tin Plate Company, Ltd., has prepared a brochure entitled "Tinplate", which has just been issued by the Company. The treatise contains a brief non-technical description of the manufacture of the product beginning with the iron ore in the blast furnace to the finished tinplate and the development of the tinplate industry in Great Britain. Copies of this booklet may be obtained from the offices of the Company, Llanelly, South Wales at seventy-five cents per copy.

A. E. WALKER

JOHN C. HOPKINS

JAMES F. LINCOLN

**A. E. Walker,** formerly general manager of sales of Republic Steel Corporation, Cleveland, effective January 1, became executive vice president of Pittsburgh Steel Company, Pittsburgh, Pa.

Mr. Walker was graduated from the engineering department of the University of Michigan in 1910, after which he went to work for the Riter-Conley Company now part of the Bethlehem Steel Company. In 1911 he entered the employ of the LaBelle Iron Works, now a part of the Wheeling Steel Corporation, as a salesman. He became associated with the Republic Iron and Steel Company at Youngstown, Ohio in 1916; was made assistant general manager of sales there in 1919 and general manager of sales in 1928. Since the formation of the Republic Steel Corporation in 1930 he has been general manager of sales of the larger organization and at the time of his resignation to become associated with Pittsburgh Steel Company he was also president of Truscon Steel Company and Niles Steel Products Company, subsidiaries of Republic Steel Corporation.

▲

**John C. Hopkins** has been elected vice president and sales manager of The Wellman Engineering Company, Cleveland, Ohio. Mr. Hopkins is widely known throughout the steel industry. He assumed his new position January 1st.

After attending Case School, he became identified with the Penn Iron and Coal Co., the Buffalo Union Furnace Co., Republic Iron & Steel Co., Massillon Iron & Steel Co., and in 1911 became associated with the American Steel & Wire Co., Central Furnace division, Cleveland, and held various positions at all of the Company's blast furnace plants, being appointed Superintendent of the Central Furnaces in 1922 and in 1929 became the general superintendent of blast furnaces and steel works, in which capacity he served until his appointment in 1934 as the District sales manager of the General Refractories Co., Cleveland office, which position he resigned to join the Wellman organization.

**James F. Lincoln,** President of The Lincoln Electric Co., in whose honor his company has named its newly created Foundation to encourage scientific development of arc welding.

The sole purpose of this new Foundation is to challenge the attention of manufacturers whose products benefit society; and to stimulate the ingenuity of every engineer and skilled worker interested in extending the frontiers of knowledge and achievement.

▲

**John Edward Daily** has been appointed district manager of the Youngstown Sheet & Tube Co., for the Chicago district, according to W. B. Gillies, vice president. His appointment was effective Jan. 1st.

Mr. Daily was born at Terre Haute, Ind., and is a graduate of the Rose Polytechnic Institute. He entered the steel industry nearly thirty years ago, being first employed at the Ohio works of the Carnegie Steel Co. in Youngstown. When the Brier Hill Steel Co.'s works were first opened he was employed there. Mr. Daily subsequently served as vice president in charge of operations at the Timken Steel & Tube Co. in Canton, and in 1932 and 1933 was general manager of the Wheeling Steel Co. at Steubenville. He joined the Youngstown Sheet & Tube Co. as general superintendent of its Indiana Harbor works on Jan. 1, 1934.

▲

**F. Hughes Moyer,** formerly associated with William M. Bailey Company, Pittsburgh, and previously in charge of engineering for Mackintosh-Hemphill Company, Pittsburgh, has been retained in an advisory capacity in the operating department of National Tube Company, Pittsburgh. Mr. Moyer is well known in steel circles and among many previous affiliations he has held executive positions with the Cambria Steel Company and Pittsburgh Crucible Steel Company.

S. S. MARSHALL, JR.

FLOYD A. BEATTY

**S. S. Marshall, Jr.**, assistant general manager, Jones & Laughlin Steel Corp., Pittsburgh, Pa., has been named general manager. Mr. Marshall's entire steel business experience has been with Jones & Laughlin. He started in 1903 as a stake drive with the Civil Engineering department and advanced successively as master mechanic; assistant superintendent, Eliza Works; assistant superintendent, South Side Works; general superintendent, South Side Works; and general superintendent, Pittsburgh Works.

**Floyd A. Beatty**, formerly vice president in charge of engineering Lewis Foundry & Machine Company, Groveton, Pa., has been appointed operating vice president. Mr. Beatty joined the Lewis organization in 1925 as assistant to the chief engineer.

Fred H. Fanning, assistant chief engineer, has been named chief engineer. He has been with Lewis Foundry & Machine since 1927.

## *Died*

**John Brua**, formerly head of the cold mills of the Ford Motor Company and recently associated with the electrical engineering department of United Engineering & Foundry Company, was fatally injured in an automobile accident on December 26, 1936.

Mr. Brua was first associated with the Jones & Laughlin Steel Corporation as a lineman and subsequently advanced to the engineering department as an electrical engineer. Mr. Brua had been a member of the Association for many years.

**James A. Riles** for forty five years identified with the electrical departments of the Carnegie-Illinois Steel Corporation, Homestead, Pa., McClintic Marshall Company, Pittsburgh, Pa., and A. M. Byers Company, Pittsburgh, Pa., in various capacities, died in his home December 12, 1936, following a brief illness. Mr. Riles was an active member of the Association of Iron and Steel Engineers for twenty five years.

▲

**Benjamin Lewis Hirshfield**, a director of the Blaw-Knox Company, died January 2 at his home at Vernon, Pa. Mr. Hirshfield was born on January 23, 1873.

JOHN BRUA

JAMES A. RILES

BENJAMIN L. HIRSHFIELD